Volume 23, Number 19, October 15, 1969

NUCLEAR SCIENCE ABSTRACTS

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Index References

All index entries refer the reader to volume and abstract number:

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FOURRIER, Alain
  Radioactive chain of mass number 189,  21:10023
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Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

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MONTH, M.
  Theory of gradient perturbations in AGS,  21:9872 (BNL-
    10899)
MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
    form factors of the deuteron,  21:9744
```

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

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NUCLEAR MODELS
  collective, rotational motions in, (T),  22:37383
  Davydov, non-adiabaticity of beta vibrations in even-even
    rare-earth nuclei, (T),  22:37375 (AD-664798)
  Hartree--Fock--Bogolyubov projected spectra for finite
    nuclei, (T),  22:37392
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URANIUM OXIDES UO2
  analysis for microdiffusions of tungsten, laser sampling
    techniques for spectroscopic,  22:35759
  analysis of irradiated, electron-microprobe,  22:36543
    (ANL-7450, pp 39-74)
  deformation at 1100°C of monocrystals of, pneumatic
    impaction,  22:36534 (BNWL-724)
  drying prior to sintering of extruded rods of, process
    for,  22:36531(P)
  electron diffraction on single-crystal surfaces of,
    effects of crystal surface on,  22:36549
  etching of,  22:36526 (LA-DC-9616)
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Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

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UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
    storage containers,  21:8500 (Y-1561)
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Report Numbers

Technical report literature is also indexed by report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

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TID-
  3311(Suppl.  21-8567   Dep. mn. CFSTI $3.00 cy, $0.65 mn
    2)
  22298        21-9915   Nucl. News, 9: No. 12, 17-21 (Dec.
                           1966)
  22298        21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                           1967)
  23267        21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
                           1966)
  23267        21-8498   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23428        21-8764   Lancet, 2: 672-5(Sept. 24, 1966)
  23474        21-8528   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23478        21-8641   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23482        21-9471   Dep. mn. CFSTI $3.00 cy, $0.65 mn
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CORRECTION

Through an error in translation of the original, the unit mcuries was incorrectly translated as μcuries in certain papers in AEC-tr-6944. As a consequence the abstracts of the papers in Volume 23, Number 12 of *Nuclear Science Abstracts* are incorrect. The unit μCi should be corrected to mCi in the abstracts and abstract lines noted below:

22172 line 5
22177 line 6
22181 line 15 Page 2254
22183 line 10
22275 line 7
22277 line 2
22321 line 4
22362 lines 2 and 3
22363 lines 2 and 9
22364 lines 3 and 4
22365 line 3
22366 line 13
22367 line 3
22368 line 17
22369 lines 5 and 6
22370 line 6
22372 line 5
22388 lines 2, 8, and 10

NOTICE

A title page for Volume 23, Numbers 19–24, is included at the back of this issue for use in binding those issues.

CORRECTIONS

NSA Vol. 23, No. 13, Abst. No. 25954, line 4 should read: 177: 1395-1405(Jan. 20, 1969).

NSA Vol. 23, No. 14, Abst. No. 27125, line 1 should read: (KFK-838) THE FORMATION OF VOIDS IN METALS

NSA Vol. 23, No. 17, Abst. No. 34300, line 3 should read: bridge Research Lab., Bedford, Mass.); Lim, Y. K.; Young, P. S.

NSA Vol. 23, No. 17, Abst. No. 34375, line 6 should read: 37409. (M.O.W.)

NSA Vol. 23, No. 18, Abst. No. 35248, line 4 should read: Trans. Faraday Soc., 65: 1315-24(May 1969).

NSA Vol. 23, No. 18, Abst. No. 35249, line 4 should read: Trans. Faraday Soc., 65: 1303-14(May 1969).

Volume 23, Number 19 October 15, 1969

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 38073, 38199, 38367, and 39011.

37870 SURVEY OF NUCLEAR METHODS IN CHEMICAL TECHNOLOGY. Broda, E. (Univ., Vienna). Ind. Chim. Belge, 32: Special No., (Vol. 2), 20-3(1967).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.2).

An attempt is made to classify nuclear methods on a logical basis to facilitate assimilation by the technologist. The three main groups are: (I) tracer methods, (II) methods based on the influence of absorbers on radiations to be measured, and (III) radiation chemical methods. The variants of the first two groups are discussed in some detail, and typical examples are given. Group I can be subdivided into (1) indicator methods, (2) emanation methods, (3) radioreagent methods, and (4) isotope dilution methods, Group II into (5) activation methods, (6) absorption methods, (7) induced nuclear reaction methods, (8) scattering methods, and (9) fluorescence methods. While the economic benefits due to nuclear methods already run into hundreds of millions of dollars annually, owing to radiation protection problems radiochemical methods in the strict sense are not widely used in actual production. It is suggested that more use should be made of pilot plant tracer studies of chemical processes as used in industry. (auth)

37871 USE OF REDUCED PRESSURE FOR IMPROVING THE SENSITIVITY OF SPECTROGRAPHIC ANALYSIS [FOR BORON AND CERIUM IN STEEL]. Nikitina, O. I.; Gorevaya, A. E. Zh. Prikl. Spektrosk., 7: 166-8(1967). (In Russian).

The intensities of the lines (Å) B I 2496.7, Ce II 3201.7, Fe I 2496, and Fe I 3202.5, of the background, and the ratio of intensities of these lines to the background, were studied as functions of the pressure (100 to 760 torr) of the gas (air, O, or Ar) in which the spectra of steel containing B and Ce are excited in an ac arc. For B I and Ce II spectra, Al and C support electrodes, respectively, are used. The maximum ratio of the intensity of the B line to the background is in O at 200 torr; that of the Ce line to the background is in air at 100 torr. At these pressures the calibration graphs also have the maximum slope. The relative sensitivity for B at 300 torr in air and in O is improved by almost one order of magnitude compared with that of 760 torr. With decrease of the pressure of air to 200 torr, the relative sensitivity of determination of Ce is also improved. The method is suitable for determining 0.0005 to 0.01% of B and 0.01 to 0.1% of Ce in steel. The coefficient of variation is 3.8% for both B and Ce in air, and is 2.1% for B in O. (Referativnyi Zh.)

Chemical Procedures

37872 (EUR-4133) CHEMICAL ANALYSIS OF PLUTONIUM BEARING NON-IRRADIATED FUELS AND THEIR COMPONENTS. Maurice, M. J.; Angeletti, L. M.; Buijs, K. (European Atomic Energy Community, Karlsruhe (West Germany). Transuranium Inst.). Apr. 14, 1969. 68p. Dep.

A scheme for the analysis of plutonium-containing nuclear fuels and their components is presented and detailed procedures are given. (auth)

37873 (NBL-247) ANNUAL PROGRESS REPORT FOR THE PERIOD JULY 1967 THROUGH JUNE 1968. (New Brunswick Lab. (AEC), N. J.). Apr. 1969. 78p. Dep. CFSTI.

Progress is reported on the following studies: determination of uranium in product and fuel materials by ferrous reduction in H_3PO_4 and titration with $K_2Cr_2O_7$; rapid separation of uranium by reversed-phase chromatography and measurement by titration to a fixed potential after ferrous reduction in H_3PO_4; behavior of Pt and Au electrodes for controlled potential coulometric determination of Pu; spectrophotometric determination of Zr in $Th(NO_3)_4$; fusion of refractory plutonium oxides with $NaHSO_4$; elution behavior of large amounts of uranium from an anion exchange resin column; spectrophotometric determination of S in B; spectrophotometric determination of Ti in B; spark positioner for MS-7 mass spectrograph; effects of variability in electrode dimensions on spectrochemical carrier distillation analyses; spectrochemical determination of impurities in silicone elastomer; determination of impurities in $Th(NO_3)_4$ solutions by atomic absorption spectrophotometry; determination of impurities in uranium solutions by atomic absorption spectrophotometry; present and proposed programs for a small general purpose computer at New Brunswick Laboratory; and, elemental boron analyzed samples of high-purity(99%) and production grade(95%) boron. (J.G.B.)

37874 IMPROVEMENT IN THE SENSITIVITY OF THE SPECTROGRAPHIC DETERMINATION OF TRACE IMPURITIES IN REFRACTORY BASES. Moroshkina, T. M. Tr. Kom. Anal. Khim. Akad. Nauk SSSR, Inst. Geokhim. Anal., 16: 62-6 (1968). (In Russian).

The spectrographic determination of Fe, Ti, Al, Si, Ca, Ni, Co, Mo, Nb, and Ta in tungsten and tantalum and their oxides with a sensitivity of 1 ppM is described. Standards are prepared by introducing a standard solution of the impurity into a sample of the oxide of the refractory metal that has been analyzed by the method of additions. The samples are mixed with high-purity copper powder in the ratio 1 : 1, and sintered to a regulus, which is excited in an 8-A ac arc between copper electrodes. A calibration graph is prepared, the line of the base-element or the background being used as internal standard. The sensitivity can be improved by two orders of magnitude by chemical concentration of the impurities. In the analysis of niobium oxide, the Ta is separated by chromatography. (Referativnyi Zh.)

37875 DETERMINATION OF TRACES OF SAMARIUM IN CERIUM DIOXIDE BY THE FLUORESCENCE OF $PbSO_4$.Ce(Sm). Bozhevol'nov, E. A.; Fakeeva, O. A. Tr. Kom. Anal. Khim. Akad. Nauk SSSR, Inst. Geochim. Anal., 16: 67-73(1968). (In Russian).

Grind together 8 mg of the sample, 392 mg of $PbSO_4$ and 0.8 ml of 0.1% LiF solution, in a silica mortar for 2 to 3 min, and dry the mixture under an ir lamp. Ignite 100 mg of the dry mixture at 860° for 30 min in a 2-ml corundum crucible; to another 100-mg portion of the same mixture add 0.5 ml of Sm solution (1 μg of Sm per ml), dry, and treat as above. Record the fluorescence spectrum in the 575-nm region, with excitation by a mercury lamp, and calculate the Sm content from the heights of the peak at 575 nm for the sample and the standard. The error is ±16%. There is no interference from 100-fold amounts of Bi, Tl, Cu, Sn, or Sb. Other rare-earth metals quench the fluorescence due to Sm; Fe(III) decreases it by ≈20%, and Cr(III) by ≈40%. (Referativnyi Zh.)

37876 SOME SHORT-LIVED FISSION PRODUCTS IN THE REGION OF THE RARE EARTHS. Guenther, E. W.; Starke, K.

(Univ., Marburg, Ger.). Radiochim. Acta, 11: 134-8(June 1969). (In German).

Nuclides representing rare earth, earth alkali, and alkali elements were separated from other fission products of uranium by anion exchange and treatment with fuming nitric acid. They were then fractionated by electrophoretic focusing of ions. The following pairs of nuclides were obtained within 20 min after the end of irradiation: $^{142/143}$La, ^{146}Ce/^{146}Pr, $^{148/147}$Pr, $^{149/151}$Nd, and $^{94/95}$Y. They were identified by gamma-spectrum and half-life. (auth)

37877 SEPARATION OF RADIOACTIVE RARE EARTHS BY ELECTROPHORETIC ION FOCUSING. Guenther, E. W.; Starke, K. (Univ., Marburg, Ger.). Radiochim. Acta, 11: 131-4(June 1969). (In German).

Radioactive isotopes of the light rare earths lanthanum to promethium and yttrium were separated from each other by electrophoretic focusing of ions on a paper strip in 3 min. The effects of time, amount of carrier, composition of the electrolyte, voltage, current intensity, moistening and cooling of the paper strip on the quality of separation were studied. The method is shown to be particularly suitable for isolating carrier-free fission products. (auth)

37878 SPECTROPHOTOMETRIC DETERMINATION OF PLUTONIUM IN DEHPA–DIOXANE SOLUTIONS WITH ARSENAZO III. Wolf, P.; Reinhardt, J. (Kernforschungszentrum, Karslruhe, Ger.). Radiochim. Acta, 11: 128-30(June 1969). (In German).

A rapid method for the determination of plutonium in the organic phase following solvent extraction is described. Plutonium is extracted out of nitric acid solutions with di(2-ethyl-hexyl) orthophosphoric acid (indexed as the bis(2-ethylhexyl)ester of phosphoric acid) and, after dilution of the extract with dioxane–HNO_3, determined photometrically with 3,6-bis[(o-arsenophyl)-azo]-4,5-dihydroxy naphthalene-2,7-disulfonic acid (arsenazo III), indexed as 2,2′-[(1,8-dihydroxy-3,6-disulfo-2,7-naphthylene)bis(azo)] dibenzenearsonic acid. The method is particularly suitable for determining plutonium of 0.1 to 2.5 μg/ml in waste solutions with an accuracy of ±3%. A minimum concentration of 1 μg Pu/50 ml is required. (auth)

37879 RADIOISOTOPE ANALYTICAL TECHNIQUES IN MINERAL PROCESSING. Lane, E. A.; Wyatt, J. S. (Australian Atomic Energy Commission, Lucas Heights). At. Energy Aust., 12: No. 2, 10-13(Apr. 1969).

Newly developed radioisotope x-ray techniques of analysis for use in mineral processing in Australia are reviewed. The on-stream analyzers at the Zinc Corporation, Ltd., plant at Broken Hill are the first radioisotope installations in the world in routine use for the continuous analysis of slurries in mineral processing. (J.G.B.)

37880 OXYGEN ISOTOPIC COMPOSITION OF SULPHATES. PART 5. ISOTOPIC COMPOSITION OF SULPHATE IN RAIN WATER, GRACEFIELD, NEW ZEALAND. Mizutani, Y.; Rafter, T. A. (Inst. of Nuclear Sciences, Lower Hutt, N. Z.). N. Z. J. Sci., 12: 69-80(Mar. 1969).

Rainwaters were collected at Gracefield, and analyzed for the oxygen and sulphur isotopic ratios in their sulphates in an attempt to investigate the origin of atmospheric sulphate. From a study of these measurements and their relationship to the chloride and sulphate concentrations in these rainwaters, it was found that seawater spray is one of the main sources of sulphates in these rains. Another possible main source of sulphate is from SO_2 produced by industrial activity. This industrially produced sulphur is enriched in ^{34}S by 20% relative to the sulphur in seawater sulphate and it can form sulphate having δ ^{18}O values of 6 to 18% through reactions with atmospheric oxygen, moisture, and rainwater. The H_2S released from seawater sulphate by biological activities is considered to be only a minor source of sulphur in Gracefield rainwaters. (auth)

37881 DETERMINATION OF TELLURIUM AND ZINC IN SEMICONDUCTOR MATERIALS WITH AN ALTERNATING-CURRENT POLAROGRAPH. Veselago, L. I.; Gertseva, N. S. Tr. Kom. Anal. Khim. Akad. Nauk SSSR, Inst. Geokhim. Anal., 16: 150-4(1968). (In Russian).

Tellurium is determined at −1.0 V (vs the mercury pool) in a basal solution of 0.5 M $HClO_4$–M H_3PO_4. The current varies rectilinearly with Te concentration in the range 0.06 to 2 mg per liter. Sb and Ga do not interfere, but Se or Zn reduces the height of the Te peak. After removal of Sb by distillation with HBr, Zn is determined in a basal solution of M H_3PO_4 at −1.35 V in the concentration range 0.2 to 12 mg per liter; 10-fold amounts of Ni and 100-fold amounts of Co (relative to Zn) are tolerated. Up to 0.1 g of Fe^{3+} per liter does not affect the determination of Zn, but higher concentrations reduce the height of the Zn peak. In the procedure for Te, the sample is dissolved in HCl–HNO_3 (4:1) without heating, set aside for several hours until the solution is colorless (removal of N oxides), diluted to a known volume with the basal solution, and the polarogram is recorded. For Zn, the sample is dissolved in the HCl–HNO_3, and the solution is evaporated almost to dryness three times with 4 ml of HCl–HBr (1:1). HBr is removed by adding HCl and evaporated almost to dryness. The residue is dissolved in H_2O, 20 ml of the basal solution is added, diluted to 100 ml, and the polarogram is recorded. From 0.001 to 0.2% of Te or Zn can be determined. With 0.1 to 0.5 g of sample, the error is <10% for 0.01 to 0.2% of Te or Zn, and <23% for 0.002%. (Refer. Zh.)

37882 DETERMINATION OF IMPURITIES IN HIGH-PURITY SUBSTANCES BY USING DIANTIPYRINYLMETHANE. Zhivopistsev, V. P.; Petrov, B. I.; Selezneva, E. A.; Sibiryakov, N. F. Tr. Kom. Anal. Khim. Akad. Nauk SSSR, Inst. Geokhim. Anal., 16: 80-3(1968). (In Russian).

4,4′-Methylenediantipyrine(I) quantitatively extracts Sb, Bi, Cd, Zn, and Sn from media 2.5 to 3 N in HCl; Sc and Bi from media 0.2 to 0.3 N in HNO_3; and Hf from a medium 6 N in HNO_3. This fact is used to concentrate these elements before their spectrochemical determination in pure Al. For the procedure 0.5 to 1 g of the sample is dissolved in 6 N HCl, diluted to give ≈150 ml of solution 3 N in HCl, 0.1 to 0.2 g of ascorbic acid is added to reduce Cu, and the impurities are extracted into 15 ml of $CHCl_3$ containing 0.5 g of (I) (shaken for 10 to 15 min). The extraction is repeated twice, the combined extracts are evaporated, 2 ml of concentrated H_2SO_4 are added, the mixture is evaporated until no more fumes are evolved, and the residue is ignited. After cooling, 2 ml of concentrated H_2SO_4, 1 ml of a Zr salt solution (≡60 μg of Zr), and 0.1 g of C powder is added, evaporated to dryness, and again ignited. The residue is then analyzed spectrographically for Sb, Bi, Cd, Zn, and Sn (Zhivopistsev and Makhnev, Analyt. Abstr., 13: 2976(1966)) with the Zr line at 2571.4 A as internal standard. An analogous procedure is used for extracting Sc, Bi, and Hf from nitrate solutions. (Refer. Zh.)

37883 STUDIES OF THE ISOTOPIC DISTRIBUTION IN ORGANIC MOLECULES BY MEANS OF A FIELD-TYPE MASS SPECTROMETER. Gol'denfel'd, I. V.; Korostyshevskii, I. Z. (Inst. of Physical Chemistry, Kiev). Isotopenpraxis, 5: 151-6 (Apr. 1969). (In Russian).

The possibility of a direct isotopic analysis of organic compounds by ionization in a strong electric field was investigated. A description is given of the arrangement, the ion-optical systems, and the mass spectra of a mixture of deuterated benzene, chlorobenzene, and chloroform. The advantages of this procedure for a direct isotopic analysis of organic compounds and the possibility of their application for the investigation of the mechanism of catalytic processes are demonstrated. (auth)

37884 RAPID ANALYTICAL METHOD FOR INVESTIGATION OF METALS AND INORGANIC RAW MATERIALS. XVII. SEPARATION OF ZIRCONIUM ON SILICA GEL AND ITS DETERMINATION IN SILICATES. Sulcek, Z. (Central Inst. of Geology, Prague); Kremer, J.; Dolezal, J. Collect. Czech. Chem. Commun., 34: 1720-30(June 1969). In German).

The possibility of zirconium separation from other elements by sorption on silica gel under static conditions was investigated. On decomposition of silicates zirconium is selectively adsorbed on silica gel from 0.5 to 1.0 N HCl. The Zr is then eluted from the column and spectrophotometrically determined using Arsenazo III. Hafnium and fluoride ions disturb the determination. (tr-auth)

37885 MEASUREMENT OF TOTAL BETA-RADIOACTIVITY OF NATURAL WATERS BY A NEW EVAPORATION METHOD. Picer, M. (Institut za Medicinska Istrazivanja i Medicina Rada, Zagreb). Arh. Hig. Rada Toksikol., 19: 225-32(1968). (In Serbo-Croatian).

A very simple, reproducible, and relatively short evaporation procedure for detecting gross beta radioactivity of natural waters has been developed. The experiments were performed on the samples of rain, river, and cistern waters artificially contaminated with 4-year-old fission products and on the samples of natural waters contaminated with fallout. (auth)

37886 AMPEROMETRY WITH TWO POLARIZABLE ELECTRODES. CHELOMETRIC DETERMINATION OF RARE EARTHS. Vydra, Frantisek; Horacek, Jan (Polarographic Inst., Prague). Anal. Lett., 1: 31-7(1967).

The method of determining rare earths by chelometric EDTA titration with biamperometric end-point indication using two stationary platinum electrodes was studied. The convenient pH range for the determination of lanthanum is 5.0 to 8.0; for yttrium 3.5 to 8.0; and for ytterbium 3.0 to 8.0. Rare earths were determined

in the presence of iron and thorium. Iron and thorium can be titrated at pH 1.5 to 2.0 and rare earths of the lanthanum group can be determined by successive titration at pH 5.0. Large amounts of rare earths of the yttrium group interfere with the determination of iron and thorium. (auth)

37887 FLAME EMISSION SPECTROMETRIC METHOD FOR DETERMINATION OF MOLYBDENUM IN STEELS. Syty, Augusta; Dean, John A. (Univ. of Tennessee, Knoxville). Anal. Lett., 1: 241-7(1968).

After normal dissolution steps, molybdenum(VI) is extracted into methyl isobutyl ketone as a suspension of the α-benzoinoxime complex. The solution is cleared with 8-hydroxyquinoline and aspirated into a fuel-rich, oxygen–acetylene flame. Emission intensity is measured at 3798 A. Observation height is slightly above the tip of the blue inner cone. The detection limit is 0.5 μg/ml. Results are given for several steels. (auth)

37888 FLAME EMISSION SPECTROMETRIC METHOD FOR NIOBIUM IN STEELS. Eskew, John B.; Jennings, Elizabeth A.; Dean, John A. (Univ. of Tennessee, Knoxville). Anal. Lett., 1: 947-54(1968).

Following dissolution steps, niobium(V) is extracted into methyl isobutyl ketone in the form of a heptafluoride complex. Stannous chloride is added to the aqueous solution to reduce iron(III) to an unextracted iron(II) species. The organic solution is then aspirated into a fuel-rich acetylene–oxygen flame and the emission intensity measured at 4059 Å. Optimum observation height is slightly above the tip of the blue inner cone. Detection limit is 13 μg/ml. Results are given for two steel samples. (auth)

37889 LUMINESCENT DETERMINATION OF GADOLINIUM, EUROPIUM, AND SAMARIUM AS IMPURITIES IN METALLIC URANIUM. Anikina, L. I.; Bagreev, V. V.; Dobrolyubskaya, T. S.; Zolotov, Yu. A.; Karyakin, A. V.; Miklishanskii, A. Z.; Nikitina, N. G.; Palei, P. N.; Yakovlev, Yu. V. Zh. Anal. Khim., 24: 1014-18(July 1969). (In Russian).

A method is suggested for determining gadolinium, europium, and samarium in metallic uranium by the radiation spectra of luminophores based on Y_2O_3 for gadolinium and on YVO_4 for europium and samarium. Impurities are concentrated by a chromatographic method. The luminescence is excited by a spark, and a phosphoroscope is used for measuring the spectra. The sensitivity of the determination of gadolinium, europium, and samarium is about 2×10^{-6}%. The variation coefficient is 30%. (auth)

37890 SPECTROGRAPHIC DETERMINATION OF THE RARE EARTH ELEMENTS IN PREPARATIONS OF HEAVY LANTHANIDES. Fadeeva, L. A.; Karpenko, L. I.; Beltyukova, S. V. (Inst. of General and Inorganic Chemistry, Kiev). Zh. Anal. Khim., 24: 1019-22(July 1969). (In Russian).

The effects of Lu, Yb, Tm, and Ho at a concentration of 60 to 97 or 99% on the determination of rare earth microcomponents (Y, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu) has been studied. It has been found that preparations of heavy lanthanides can be analyzed by means of the single series of standard solutions irrespective of the main component of the sample analyzed. The sensitivity of the determination by the spark method is 10^{-3} to 10^{-2} mg/ml or 10^{-2} to 10^{-1}% of Ln_2O_3. (auth)

37891 USE OF PULSE POLAROGRAPHY FOR THE ANALYSIS OF SEMICONDUCTORS OF THE $A^{III}B^{V}$ TYPE AND THEIR COMPONENTS. Kaplan, B. Ya.; Revyakina, G. N.; Reazkova, Kh. S.; Shiryaeva, O. I. Tr. Kom. Anal. Khim. Akad. Nauk SSSR, Inst. Geochim. Anal., 16: 103-5(1968). (In Russian).

Spectrochemical and pulse-polarographic techniques are compared. The latter is better for determining down to 0.1 ppM of Cu in metallic indium without removal of the In, and for determining similar concentration of Zn in semiconductor materials. This method is proposed for the determination of Te, S, and Se in metallic indium, bismuth, antimony, and gallium and in indium antimonide and gallium phosphide. Cathodic pulse polarography may also be used for the determination of $SSeO_3^{2-}$. The determination of 0.1 to 1 ppM of S is carried out in a basal electrolyte of 0.64N-KOH–0.16M-hydroxylammonium chloride. Elementary S is dissolved and reduced to S^{2-} in a 15% solution of $Na_2S_2O_3$ in 6N-HI–6N-HCl (previously purified from S); the H_2S is absorbed by the polarographic basal electrolyte. Tellurium (down to 0.01 ppM) is determined by cathodic vector polarography after concentration of elementary Te at a stationary mercury electrode. (Referativnyi Zh.)

37892 SELECTIVE GRAVIMETRIC DETERMINATION OF Ti(IV), Zr(IV), AND Hf(IV) BY MEANS OF TROPAEOLIN O AND TROPAEOLIN OOO. Tripathi, S. N.; Singh, R. S.; Agarwala, B. V.; Dey, A. K. (Univ. of Allahabad, India). Z. Anal Chem., 245: 323(May 13, 1969).

Tropaeolin O (p-benzenesulfonate-azo-resorcinol; TPO) and Tropaeolin OOO (p-benzenesulfonate-azo-naphthol; TPOOO) have been successfully used as reagents for the gravimetric determination of titanium, zirconium, and hafnium and can be conveniently applied to the separation of these elements from a large number of metal ions, such as uranium, lead, rare earths, platinum metals, and others. Only thorium has been found to interfere. Though the precipitates can be dried to constant weight, conversion to the oxides is recommended, as the weights obtained were slightly higher than should be expected from the composition of the complexes (1:2 for Ti: reagent and 1:1 for Zr and Hf). Errors found were below +0.5%. The procedure is described. (auth)

37893 EXTRACTION-ABSORPTIOMETRIC DETERMINATION OF TIN IN HIGH-PURITY INDIUM. Marchenko, P. V.; Obolonchik, N. V. Tr. Kom. Anal. Khim. Akad. Nauk SSSR, Inst. Geokhim. Anal., 16: 41-6(1968). (In Russian).

In acid medium (pH 1) $Sn^{(IV)}$ forms with lumogallion [5-chloro-3-[(2,4-dihydroxyphenyl]azo)-2-hydroxybenzenesulfonic acid; I] a 1:1 colored complex extractable into butanol and suitable for the absorptiometric determination of Sn (maximum absorption of the complex is at 510 nm). There is no interference from In, Zn, Fe, Cd, Ni, Sb, Cr, Co, or thiourea (used to mask Cu, Bi, and Pb). Oxalate, EDTA, NaF, and, to a lesser degree, tartaric and citric acids interfere. For the procedure dissolve the indium (0.1 to 0.3 g) by heating it with 8 ml of HNO_3 (1:14) containing a few drops of 0.5N HCl, boil to remove oxides of N, cool, and add 2 ml of 10% thiourea solution, 6 ml of 4% NaOH solution, and 1.2 ml of 10 μM-I. Add dilute HNO_3 until the color changes from red to orange, then dilute to 25 ml with 0.1N-HNO_3. After 10 min, extract the complex into 2 ml of butanol and compare the color with those of standards. The sensitivity is 0.5 ppM of Sn; a determination takes ≈1 hr. (Referativnyi Zh.)

37894 COMPARATIVE STUDY OF ROTATING MICROELECTRODES IN ELECTROCHEMICAL ANALYSIS. APPLICATION TO DETERMINATION OF RUTHENIUM IN CATALYSTS. Kollar; El Kouri. Method. Phys. Anal., 183-6(Oct.-Dec. 1967). (In French).

Excellent reproducibility was obtained with rotation at 600 rpm in 6N HCl for polarographic reductions in the ranges 0.1 to 0.9, −0.3 to 1.1, and −0.8 to 1.2 V vs the S.C.E. for platinum, vitreous carbon, and boron–titanium carbide electrodes, respectively. For the determination of Ru with optimum reproducibility, 1 g of the catalyst is mixed with 6 g of Na_2O_2, and heated in a platinum crucible for 2 hr at 450°. The melt is dissolved in concentrated HCl, heated to boiling point and a few drops of aqueous H_2O_2 is added. The solution is diluted to be 6N in HCl. Either a rotating platinum or carbon electrode can be used to measure the reduction of $Ru^{(IV)}$ to $Ru^{(III)}$ at 0.72 V vs the S.C.E. The limit of detection is ≈1 μg of Ru per ml; Fe, Cr, Ni, Co, and Al do not interfere. (Metals Abstr.)

37895 SPECTROGRAPHIC DETERMINATION OF TRACES OF RARE EARTHS IN RARE EARTHS OF HIGH PURITY. Donati, F. , (Centre de Recherches Pechiney-Saint-Gobain, Auber-villiers, France). Ind. Chim. Belge, 32: Special No., (Vol. 1), 166-9(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

An improvement is described in the method for the determination of trace amounts of rare earths that may be found in the oxides of yttrium, lanthanum, and gadolinium. The spectrographic procedure is based on the excitation of a rare earth oxide–graphite mixture by a dc arc. The following mixtures were examined: Dy Er, Ho, and Tb—in 5 to 2000 ppM in Y; Y, Nd, and Pr—between 5 and 200 ppM in La; Sm—between 20 and 200 ppM in Gd; and Eu in a mixture of La_2O_3–Nd_2O_3–CeO_2. In this case, the limit of detection is of the order of several parts per million. Considering its speed and the great ease of application, emission spectrography has its place as a control method in a plant for the treatment of rare earths. (tr-auth)

37896 IDENTIFICATION OF URANIUM MINERALS IN URANIFEROUS BITUMENS. Lesnoi, D. A.; Ivanov, Yu. K.; Gamarnik, M. Ya. At. Energ. (USSR), 26: 466-7(May 1969). (In Russian).

Submicroscopic mineral inclusions in uranium-bearing bitumens, such as uraninite, pitchblende, and coffinite often cannot be detected by optical microscopy; therefore, an electron microscopic method was developed for this purpose. The method made it possible to determine these particles and to determine the dimension and surface properties, although no definite identification could be made. Additional tests were carried out by microdiffraction

studies on the extracted particles. The information thus obtained was sufficient to determine with certainty that the submicroscopic inclusions consisted indeed of uraninite. Although this form of uranium could be identified as being present in uraniferous bitumens, the element could also be present in these systems in the form of organo-uranium compounds and metamict minerals. (TTT)

37897 SPECTROPHOTOMETRIC DETERMINATION OF MOLYBDENUM(VI) WITH BENZOYLACETANILIDE. Sarkar, Ajit K.; Das, Jyotirmoy (Univ. of Burdwan, Bengal, India). Anal. Lett., 2: 141-52(Mar. 1969).

The complex formed between molybdenum(VI) and benzoylacetanilide in the pH range 0.6 to 1.9 has been extracted into methyl isobutyl ketone and the absorbance has been measured at 410 mμ. Quantities of 0.15 to 2.10 mg of molybdenum have been determined with a standard deviation of 0.6%. The color is stable up to 2 hours. The presence of Co^{2+}, Ni^{2+}, Zn^{2+}, Mn^{2+}, Be^{2+}, Al^{3+}, Cr^{3+}, Ce^{4+}, Th^{4+}, or UO_2^{2+} up to 100 μg caused no interference. Ordinarily, Fe^{3+} interfered with the determination, but when masked with 1 ml of 0.5% solution of ascorbic acid the tolerance limit was 10 mg. Thus, molybdenum can be determined in steel when present in amounts as low as 0.26%. (auth)

37898 CALCULATION ERRORS IN PHOTOGRAPHIC METHODS OF SPECTROGRAPHIC ANALYSIS. Krinberg, I. A.; Smirnova, E. V. Izv. Sib. Otd. Akad. Nauk SSSR, No. 9, Ser. Khim. Nauk, No. 4, 150-2(1967). (In Russian).

A mathematical study has been made of errors in the spectrographic determination of Ce in granitoids; the errors considered were those arising (i) in construction of the characteristic curve S = f(log I) for the photographic plate, (ii) in the determination, by using the characteristic curve, of the value of $R = \log I_1/I_2$, (iii) in construction of the calibration graph $\log R = \log a + b \log C$, and (iv) in the determination, by using this graph, of the concentration C of the element to be determined. The results are presented as graphs of the coefficient of variation (V) vs. C. Values of V were (i) 1 to 10%, (ii) 5 to 23%, (iii) 4.5%, and (iv) 2%. (Referativnyi Zh.)

37899 THE DETERMINATION OF TELLURIUM IN LEAD USED FOR CABLE SHEATHING. Haase, H.-W. Z. Erzbergbau Metallhuettenw., 21: 566-7(Dec. 1968). (In German).

Four analytical techniques were investigated: photometric determination of Te as a bromotellurate complex, photometric determination as a bromotellurate complex with reference to dissolution in nitric acid–tartaric acid, photometric determination as a Te–carbaminate complex, and emission spectrum analysis. The first method was the most accurate. (Metals Abstr.)

37900 ATOMIC-ABSORPTION FLAME-PHOTOMETRIC DETERMINATION OF ZIRCONIUM. Shane, N.; Schwiegerath, R. (Bristol-Myers Products, Hillside, N. J.). Flame Notes, Beckman, 2: 96-7(1967).

Sensitivities are reported for Zr at 360.1 nm in a N_2O–acetylene flame in various acid media; the best results were obtained with HF medium. The sensitivities, expressed as percentual concentration limits for 0.1 N HF and 3 N HCl were 2 and 10 ppM, respectively. (Anal. Abstr.)

37901 DETERMINATION OF BORON, BERYLLIUM, GERMANIUM, AND NIOBIUM WITH NITROUS OXIDE–ACETYLENE FLAME. Manning, D. C. (Perkin-Elmer Corp., Norwalk, Conn.). At. Absorption Newsl., 6: No. 2, 35-7(1967).

Some information is given, and previous work is confirmed, on the operating conditions, sensitivities, and attainable detection limits for these elements with a Perkin-Elmer 303 atomic-absorption spectrophotometer. (Anal. Abstr.)

37902 AMPEROMETRIC DETERMINATION OF THORIUM IN THE PRESENCE OF OTHER METAL IONS THAT FORM STABLE COMPLEXES WITH EDTA. Khadeev, V. A.; Kochergina, S. A. Uzb. Khim. Zh., No. 6, 15-18(1967). (In Russian).

Thorium is determined by titration from the current due to the oxidation of EDTA from the Th–EDTA complex at 1.2 V at a Ta electrode. The pH of the test solution (0.4 to 4 mg Th) is adjusted to 1 to 2 and diluted to 30 ml. The EDTA solution is added until there is a sudden increase in current intensity caused by excess EDTA, and the excess is titrated with $Bi(NO_3)_3$ solution until the background current is reached. The 2.5 ml of 2N H_2SO_4 and 4 ml of saturated Na_2SO_4 are added, and the EDTA displaced by SO_4^{2-} from the Th complex is titrated with $Bi(NO_3)_3$ to a constant current. The amount of EDTA bound to the Th is found by difference. The method is applicable to the determination of Th in the presence of the following elements (tolerated amounts, as a ratio to Th, in parentheses): Fe(20), Bi(30), Zr(2), Hg and In(10), and Ce(2.5). The error is <1%. The Th and other metals may be titrated in succession. (Anal. Abstr.)

37903 ANALYTICAL CHEMISTRY OF THE LESS-COMMON OXIDATION STATES. VIII. DETERMINATION OF CERIUM(III) WITH CYANOMOLYBDATE. Vincente-Perez, S.; Cordova-Orellana, R. (Univ., Salamanca, Spain). Inform. Quim. Anal., Pura Apl. Ind., 22: No. 1, 38-45(1968). (In Spanish).

Cerium(III) is determined with cyanomolybdate by placing the solution containing the Ce (70 to 700 mg in 20 ml) in a reaction cell, bubbling N_2 through vigorously for 5 to 10 min, adding an equal volume of 1N K_2CO_3, boiling the mixture to eliminate O_2, and then titrating potentiometrically with 0.02 to 0.1N potassium cyanomolybdate, adjusted to pH 6 to 6.5 with $NaHCO_3$, at room temperature in artificial light. (Anal. Abstr.)

37904 RADON ESTIMATION IN MINERAL AND MEDICINAL WATERS. Quentin, K.-E.; Schretzenmayr, G. (Technische Hochschule, Munich). Z. Lebensm.-Untersuch. Forsch., 139: 87-96(1969). (In German).

The ^{222}Rn concentrations in mineral waters from several European sources were measured electrometrically. The methods for sampling, sample treatment, and measurement are described in detail. Sample calculations are presented. The accuracy of the method for ^{222}Rn was estimated by comparison to standard solutions over concentrations of from 4 to 10 nCi. The standard deviation was ±1% and the error was ±10%. The concentrations of ^{222}Rn measured amounted to ~20 nCi/l. The importance of the time interval between sampling and measurement is discussed in detail, and correction factors for this are tabulated for intervals of up to 60 days. Methods for calibration of the equipment used, and the parameters used for evaluation of the ^{222}Rn concentrations, are presented and defined. (BBB)

Isotopic Procedures

37905 RADIOMETRIC DETERMINATION OF OXALATE, CARBONATE, AND IODATE IONS WITH CALCIUM CHLORIDE REAGENT SOLUTION LABELLED WITH ^{45}Ca. Oemboely, Cs.; Szaras, T.; Horvath, L. (Hungarian Academy of Sciences, Budapest). Radiochem. Radioanal. Lett., 1: 149-53(July 1969).

Radiometric determination of oxalate, carbonate, and iodate ions is based on the poor water-solubility of their calcium salts. 0.1 N and 0.01 N calcium chloride reagent solutions, labelled with ^{45}Ca were used for the titrations. Conditions suitable for radiometric determination of the various ions were also studied. Radiometric titrations were carried out in an apparatus suitable for the detection of soft β-radiating isotopes. (auth)

Radiometric Procedures

Refer also to abstracts 38273 and 38362.

37906 (MLM-1654) GAMMA COUNTING OF ^{210}Po IN SOLUTION. Bishop, C. T.; Curtis, M. L.; Bolton, M. M. (Mound Lab., Miamisburg, Ohio). Aug. 12, 1969. Contract AT(33-1)-Gen-53, 7p. Dep. CFSTI.

Polonium-210 was assayed in solution by counting its 0.803-MeV gamma rays with a sodium iodide crystal and multichannel analyzer. Absolute activities were obtained by comparison with a calorimetered standard. Samples with polonium concentrations between 0.1 mCi/ml and 10 Ci/ml can be rapidly assayed with an accuracy of about 1.5% by counting after dilution to a fixed volume. (auth)

37907 RADIOMETRIC AND SPECTROPHOTOMETRIC DETERMINATION OF TRACE AMOUNTS OF SELENIUM USING 3, 3'-DIAMINOBENZIDINE AS THE INITIAL REAGENT. Wiersma, James H.; Lott, Peter F. (Univ. of Missouri, Kansas City). Anal. Lett., 1: 655-67(1968).

Radiometric and spectrophotometric procedures for determination of selenium were developed. They are based on the formation and separation of the mono- and di-piazselenols of 3,3'-diaminobenzidine. Analysis of samples, reaction conditions, and sensitivity of the procedures are discussed. (auth)

37908 MAD CARRIER: FREE METHOD FOR THE RADIOCHEMICAL DETERMINATION OF ^{137}Cs. Ellenburg, E. J.; McCown, J. J. (Westinghouse Astronuclear Lab., Jackass Flats, Nev.). Anal. Lett., 1: 697-706(1968).

A quantitative radiochemical method for determination of ^{137}Cs is based on the use of an inorganic ion exchanger, potassium cobalt ferrocyanide (KCFC). The ^{137}Cs is absorbed onto 50 milligrams of KCFC solid stirred in the sample solution with no carrier required. The procedure takes less than thirty minutes and

gives excellent separation from the fission products in normal reactor fuel solutions. (auth)

37909 RADIOMETRIC DETERMINATION OF OXYGEN AND OF CHLORIDE IONS DISSOLVED IN WATER. Rygaert, J. (Societe d'Etudes de Recherches et d'Applications pour l'Industrie, Brussels); Clauss, A.; Beaudet, C.; Constant, E. Ind. Chim. Belge, 32: Special No., (Vol. 1), 145-6(1967). (In French).

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Oxygen and chloride ions can be determined by a radiometric method. The simple procedures have made possible the production of a portable apparatus. (tr-auth)

37910 RADIOCHEMICAL DETERMINATION OF BURN-UP OF FUEL ELEMENTS. Baetsle, L. H.; Demildt, A. C.; Monsecour, M. R.; Boden, R. M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Ind. Chim. Belge, 32: Special No., (Vol. 1), 717-21(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

In order to better establish the problem, a study in depth of the nuclear phenomena that are involved in fuel elements had to be made. Aside from the fission and in consequence the production of fission products, there was found an important change in the isotopic composition of the fissile and fertile products. The radiochemical methods for the determination of the rate of combustion is thus not limited to the analysis of certain fission products but equally to the isotopic analysis of uranium and plutonium. Some classical radiochemical methods, activation analysis as well as alpha and gamma spectrometry furnish important results for the determination of "burn-up." (tr-auth)

37911 USE OF LIQUID SCINTILLATION COUNTING FOR MEASURING SELF-ABSORPTION OF ^{14}C IN DAPHNIA PULEX. Bell, R. K.; Ward, F. J. (Univ. of Manitoba, Winnipeg, Can.). J. Fish. Res. Board Can., 25: 2505-8(Nov. 1968).

The incorporation of ^{14}C in Daphnia pulex was measured by counting incorporated ^{14}C in whole dried animals using a liquid scintillation technique and then multiplying these counts by a predetermined self-absorption coefficient. Intact dried animals were allowed to settle to the bottom of vials. To determine if the fraction of ^{14}C β emissions detected was reduced by settling, dried, labeled D. pulex were placed in a scintillation vial containing 15 ml of a toluene-based scintillation solution. The mean and confidence interval for animals supported off the bottom was 2090 ± 40.33 dpm; for animals on the bottom of the vials, 2115 ± 40.54 dpm. It was concluded that settling did not result in a loss of detectable ^{14}C β emissions. Mean activities of intact and combusted animals were different ($t = 6.64$, $P < 0.01$) and variances were homogeneous ($F = 2.00$, $P > 0.10$). Self-absorption within D. pulex constituted at least 43% of β emissions. Minor losses may have been associated with the combustion technique. Previous estimates indicated that about 10% dpm were lost during combustion. The average self-absorption coefficient was 1.77. One useful modification of the procedure would be the elimination of the need to freeze by immersion in liquid nitrogen. Instead, phenethylamine could be injected into the vial and the serum cap subsequently be replaced with a scintillation vial cap. (BBB)

37912 USE OF ALPHA-PARTICLE SCATTERING FOR THE QUALITATIVE ANALYSIS OF ELEMENTS IN SOLUTION. Peisach, M. (Southern Universities Nuclear Inst., Faure, South Africa). J. S. Afr. Chem. Inst., 22: 50-6(Jan. 1969).

The technique of analysis by elastic scattering of charged particles, which previously was useful only for the analysis of surface layers, was extended to include the analysis of solutions. The method provides a rapid and sensitive identification of light and medium weight elements irrespective of the chemical form in which the elements occur. It has the disadvantage that volatile components are lost, often before their presence can be noted. The same technique makes it possible to prepare thin targets of any element for nuclear studies, particularly of those elements for which targets could not readily be prepared by distillation in vacuum. It was shown that a light element such as C would be suitable for a sample support because the maximum energy of an α particle scattered from the sample support would, for most elements, be less than that scattered from an element in the sample and would thus not interfere with the detection of the element. Carbon would not be detectable in the sample, nor would the 3 lighter elements B, Be, and Li be readily detected. Preparation of the sample is described. Self-supporting C foils, in which α particles of 5 MeV lose less than 15 keV, were made by sputtering onto glass using an arc between C electrodes. (BBB)

37913 γ-SPECTROMETRIC MEASUREMENTS OF K, U, AND Th IN SEVERAL MAGMATITES. Agiorgitis, G.; Rank, D. (Bundesversuchs- and Forschungsanstalt Arsenal, Vienna). Tschermoaks Mineral. Petrogr. Mitt., 12: 470-8(1968). (In German).

Concentrations of U and Th in various basaltic or intermediarite rocks were measured by γ spectrometry. Methods of analysis and the γ spectral bands used are discussed. Concentrations of U and Th were reported to increase directly with increases in degree of differentiation, and increase linearly with the concentration of SiO_2 in rapidly cooled magma. The values for Th and U found were similar to values typical of granitic rocks. The concentrations of U and Th ranged from 0.2 to 5.8, and from 0.2 to 26.3 ppM, respectively. The mean value of the Th/U ratio was 2.5, which was higher than previously reported elsewhere. It was not possible to ascertain if the concentrations of U and Th found were due to contamination from the continental sial. (BBB)

Activation Procedures

Refer also to abstracts 37976 and 38302.

37914 (KFK-863) DETERMINATION OF SOME TRACE ELEMENTS IN RHINE WATER BY NEUTRON ACTIVATION ANALYSIS. Schmidt, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Dec. 1968. 70p. (In German). Dep.

Water from the Rhine River was examined for the presence of Zn, As, Se, Br, Sr, Zr, Mo, Ag, Cd, In, Sn, Sb, Te, Cs, Ba, Ce, and U by neutron activation analysis. Samples were taken monthly from the vicinity of Karlsruhe from July 1965 to June 1966. After the samples were evaporated to dryness, the residues were irradiated together with known standards in the Karlsruhe Reactor FR-2. By use of a carrier technique the elements were isolated and then determined by γ spectroscopy. The average of the analytical values for Zn, As, Br, Rb, Zr, Mo, and Ce are in the one $\mu g/l$ range, while the averages for Ba are a factor of 10, and for Sr a factor of 100 higher. The average values for Se, Sb, Cs, and U are a factor of 10, and for Ag a factor of 100 lower. The analytical results are tabulated and the dependence of withdrawal time of the samples are illustrated graphically. Cd, In, Sn, and Te were not detected. For the elements studied the experimental limits of detection are 10^{-5} μg for Br, Ag, In, Sb, and Cs, 10^{-4} μg for Zn, Se, Rb, Ba, and Ce, 10^{-3} μg for Zr, Mo and U, 10^{-2} μg for As, Sr, and Te, 10^{-1} μg for Cd and 10^{0} μg for Sn. For As a dependence on the flow rate of the Rhine was shown. In addition Sr, Br, Rb, and Ba are strongly dependent on the inflow of industrial wastes (upper Rhine potash mining industries). Mo, Cs, and Zr show a dependence on the seasonal time, while Ag and Zn are dependent on all three factors. These results are comparable to those of other workers. (auth)

37915 DETERMINATION OF MOLYBDENUM IN STEELS AND BIOLOGICAL MATERIALS BY ACTIVATION ANALYSIS. LaFleur, P. D. (National Bureau of Standards, Washington, D. C.). Radiochem. Radioanal. Lett., 1: 225-9 (July 1969).

A procedure for determining molybdenum by activation analysis in steels and biological matrices is described. The procedure involves a chemical separation of molybdenum by solvent extraction using the reagent hydrogen bis(2-ethyl hexyl) phosphate, and subsequent back extraction with $HNO_3-H_2O_2$. Using the procedure as described precisions of 1 to 2% (at the 95% confidence level) are possible and 3 to 4% are routine. (auth)

37916 RADIOCHEMICAL SEPARATIONS FOR DETERMINATION OF TIN IN ROCKS BY NEUTRON ACTIVATION ANALYSIS. Schmidt, Diether; Starke, Kurt (Univ., Marburg, Ger. Technische Hochschule, Garching, Ger.). Radiochim. Acta, 11: 197-202(June 1969). (In German).

A new method for the neutron activation determination of tin in rocks via γ-emitting ^{123}Sn was developed. The short half-life of 40 min required an improved, more rapid procedure for the radiochemical separation. The samples were irradiated for 1 h, together with a tin standard solution, dissolved by fusion in Na_2O_2/NaOH, and the main interfering activities removed by liquid-liquid-extraction of tin with TTA in methyl isobutyl ketone. Further purification was done by successive extraction steps and back-extraction of tin with tartaric acid. The liquid samples were measured by gamma spectrometry, using the ^{123}Sn-peak at 160 keV. The chemical yield was determined by counting, after 1 d, the 391 keV-peak of 104 min ^{113m}In, daughter nuclide of 115 d ^{113}Sn tracer, which was added with tin carrier. Total chemical yields of 45%, 1.5 h processing time required between irradiation and counting, and the radiochemical purity achieved were sufficient to determine tin in the 1 to 10 ppM range. Results are reported for the USGS standard rock W-1 and a German granite. (auth)

37917 NEUTRON ACTIVATION ANALYSIS METHOD FOR THE DETERMINATION OF OXYGEN. Rafaeloff, R. (Soreq Nuclear Research Centre, Yavne, Israel). Radiochem. Radioanal. Lett., 1: 199-202(July 1969).

Oxygen in the range 25 to 250 mg in organic compounds was determined by using lithium compounds as a triton source and counting the ^{18}F produced. (auth)

37918 A SIMPLE NEUTRON ACTIVATION METHOD FOR SILVER IN ROCKS. Brunfelt, A. O. (Univ. of Oslo); Steinnes, E. Radiochem. Radioanal. Lett., 1: 219-24(July 1969).

A simple radiochemical procedure was developed. The method consists of 3 separate steps after the alkaline fusion. (auth)

37919 DETERMINATION OF FLUORINE, CHLORINE, BROMINE, AND IODINE IN A SINGLE SAMPLE BY PHOTON ACTIVATION ANALYSIS. Wilkniss, Peter E. (Naval Research Lab., Washington, D. C.). Radiochim. Acta, 11: 138-42(June 1969).

The determination of fluorine, chlorine, bromine, and iodine in a single sample by photon activation analysis was investigated. The reactions $^{19}F(\gamma,n)^{18}F$, $^{35}Cl(\gamma,n)^{34m}Cl$, $^{81}Br(\gamma,n)^{80m}Br$, and $^{127}I(\gamma,n)^{126}I$ were utilized. Interfering reactions of the types $(\gamma,\alpha n)$, (γ,p), (p,n), (p,α) and neutron induced reactions are discussed. The radiochemical procedure used to separate the produced radionuclides is described. The lower limits at which F, Cl, Br, and I can be determined to ±10% were found to be 5×10^{-6} g F, 5×10^{-7} g Cl, 1×10^{-7} g Br, and 2×10^{-7} g I. (auth)

37920 DETERMINATION OF NITROGEN IN PETROLEUM PRODUCTS BY FAST-NEUTRON ACTIVATION AND MATRIX EFFECTS. Tamura, Mituhisa (Government Resource Research Inst., Saitama, Japan). Radioisotopes (Tokyo), 18: 252-7(July 1969). (In Japanese).

The nitrogen analysis of petroleum products by means of the $^{14}N(n,2n)^{13}N$ reaction with 14-MeV neutrons was investigated. In order to avoid the various errors caused by the variation of the neutron flux, a rotation method, in which both an unknown sample and a standard sample are irradiated by the same neutron flux, was adopted. For hydrocarbon samples the $^{12}C(p,\gamma)^{13}N$ and $^{13}C(p,n)^{13}N$ reactions with recoil protons and matrix effects have prevented the determination of a small amount of nitrogen. By a series of experiments on the relation between the effects and the compositions of hydrocarbons, it was found that the effects depend only on the weight fraction of carbon (W_C). Furthermore, it was found that, in the narrow range of the W_C, the effects may be expressed by a linear equation of the weight fraction. This relation has made it possible to obtain the fairly good results for the sample whose W_C-value is known and the nitrogen content is more than 0.1%. This method is particularly suitable for the analysis of nitrogen in fuel oils because they contain some considerable amounts of nitrogen and have nearly equal W_C-value which is 85%. About 25 minutes were required for an analysis, but the time will considerably be shortened by increasing the neutron flux and improving the counting technique. (auth)

37921 ESTIMATION OF POTASSIUM, RUBIDIUM, AND CAESIUM IN STANDARD AND ULTRAMAFIC ROCKS USING NEUTRON ACTIVATION. Gangadharam, E. V. (Univ. of Saugar, India); Reddy, G. R. Radiochim. Acta, 11: 90-3(Apr. 1969).

Neutron activation methods for the determination of potassium, rubidium and cesium are described. The radiochemical separations are based on the precipitation of cobaltnitrites of potassium, rubidium and cesium and in the case of rubidium and cesium on an ion-exchange separation using ammonium molybdophosphate. Potassium, rubidium and cesium are finally precipitated as their tetraphenylborates for radioactivity measurements. Potassium, rubidium and cesium contents of some ultramafic rocks of southern India and rubidium and cesium contents of the new U. S. Geological Survey standards obtained by neutron activation are presented. (auth)

37922 REPEATED PULSE ACTIVATION ANALYSIS FOR MEASUREMENT OF SHORT HALF-LIFE RADIONUCLIDES. Tani, A.; Matsuda, Y.; Yuasa, Y.; Kawai, N. (Nippon Atomic Industry Group Co., Ltd., Kawasaki, Japan). Radiochem. Radioanal. Lett., 1: 155-61(July 1969).

A simple instrumental system was devised for repeated pulse activation analysis on radionuclides with half-lives ranging from microsecond to second. γ-ray spectra of ^{24m}Na with a half-life of 20 msec were observed and also ^{206m}Pb and ^{207m}Pb with half-lives of 4 msec and 800 msec. The feasibility of the system for activation analysis on short half-life radionuclides was discussed. (auth)

37923 INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF BIOLOGICAL MATERIALS. Nadkarni, R. A.; Flieder, D. E.; Ehmann, W. D. (Univ. of Kentucky, Lexington). Radiochim. Acta, 11: 97-100(Apr. 1969).

Thermal neutron activation analysis coupled with gamma-ray spectrometry with a high resolution Ge(Li) detector and a multichannel analyzer was used to determine the concentrations of Br, Au, La, Hg, Zn, Se, Ag, and Sc in diverse biological samples such as canine dental calculus, human connective tissues, human squamous epithelium, human blood plasma, tobacco leaves, and seven different brands of commercial cigarette tobacco. An attempt is made to correlate the concentrations of these elements with normalcy of the tissues. (auth)

37924 NONDESTRUCTIVE RAPID DETERMINATION OF FLUORINE BY NEUTRON ACTIVATION. Henkelmann, R.; Staerk, H.; Born, H.-J. (Technische Hochschule, Munich). Radiochim. Acta, 11: 101-4(Apr. 1969). (In German).

In connection with the fast pneumatic tube system, the neutron spectrum of the Munich research reactor permits a rapid and nondestructive activation analysis of fluorine. Using the nuclear reaction $^{19}F(n,\gamma)^{20}F$ the detection limit is about 1 μg for ^{20}F (11 sec). If high matrix activities are interfering, the reaction $^{19}F(n,p)^{19}O$ is used with a detection limit of about 50 μg. The activation of the sample by thermal neutrons is suppressed by cadmium. The method, very suitable for fluorine determination in organic compounds, was also checked for other matrix elements. (auth)

37925 THE SIMULTANEOUS DETERMINATION OF RUTHENIUM AND OSMIUM BY A RADIOCHEMICAL METHOD. Chung, K. S.; Beamish, F. E. (Univ. of Toronto). Anal. Lett., 1: 45-52(1967).

A simple radiometric procedure is proposed for the simultaneous determination of microgram amounts of ruthenium and osmium by neutron activation. After irradiation, the tetroxides of both metals were collectively distilled and then determined directly by measuring the photopeak areas of ^{191}Os and ^{103}Ru at 45 and 498 keV, respectively. The effect of Compton continua was negligible. (auth)

37926 DERIVATIVE NEUTRON ACTIVATION DETERMINATION OF MAGNESIUM. Smathers, James B. (Walter Reed Army Inst. of Research, Washington, D. C.); Duffey, Dick; Lakshmanan, Sitarama. Nucl. Appl. Technol., 7: 84-8(July 1969).

A derivative neutron activation procedure determines the element magnesium using the chelating agent 5,7-dibromo-8-hydroxyquinoline. By selective solvent extraction, the magnesium chelate is isolated from interfering elements and separated from excess chelating agent using paper chromatography. The amount of magnesium present is then inferred from the bromine activity after neutron irradiation of the isolated chelate. The method improves the sensitivity for magnesium detection by a factor of five and removes the time constraint characteristic of conventional activation determination of magnesium. (auth)

37927 APPLICATIONS OF NEUTRON ACTIVATION METHOD FOR ^{53}Mn IN METEORITIC IRON. Imamura, M.; Matsuda, H.; Horie, K.; Honda, M. (Tokyo Univ.). Earth Planet. Sci. Lett., 6: 165-72(May 1969).

A highly sensitive determination of ^{53}Mn by a neutron activation method which was proposed by H. Millard, Jr., (Science, 147: 503(1965)) was examined in detail. A reference source of ^{53}Mn was extracted from an iron meteorite and the activity was standardized using x-ray and gamma counters. The cross section and the interferences due to the Mn(n,2n) and Fe(n,p) were studied under several different irradiation conditions. The appropriate chemical process before and after irradiation was studied. Some applications of this method, especially the examination of local distributions of ^{53}Mn in iron and stone meteorites, were performed. The ^{53}Mn content in an iron target bombarded by a high energy proton was determined in the presence of ^{54}Mn. An artificial method is proposed for the preparation of a ^{53}Mn source essentially free from ^{54}Mn. (auth)

37928 ACTIVATION-ANALYSIS DETERMINATION OF IMPURITIES IN CERTAIN SEMICONDUCTOR MATERIALS. Artyukhin, P. I.; Gil'bert, E. N.; Pronin, V. A. Tr. Kom. Anal. Khim. Akad. Nauk SSSR, Inst. Geokhim. Anal., 16: 169-75 (1968). (In Russian).

Procedures are described for the neutron activation determination of traces of Au, Sb, Ga, and Fe in arsenic and silicon, traces of Sb, Ga, Fe, Zn, In, Cu, Co, As, Sn, and Te in thallium, and 18 trace impurities in trichloromethylsilane, silicon, silicon carbide, and germanium. The samples and standards are irradiated in a nuclear reactor and dissolved, the base components are removed,

and the elements to be determined are separated by extractive chromatography into groups suitable for γ spectrometry. Bis-2-chloroethyl ether, alkylbenzyldimethylammonium chloride, and dibutyl phosphorothioate are used as group extractants for the analysis. (Referativnyi Zh.)

37929 METHOD FOR THE RAPID DETERMINATION OF IRON, ALUMINUM, AND SILICON IN PEDOLOGY: ACTIVATION ANALYSIS USING 14-MeV NEUTRONS WITHOUT RADIOCHEMISTRY. Garrec, Jean-Pierre; Fer, Andre; Fourcy, Andre (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. D, 268: 3021-4(June 23, 1969). (In French).

Analyses were carried out for iron, aluminum, and silicon in soils. The analysis is concerned with the total element, but it could be carried out in the same manner on the exchangeable part. As an illustration, a soil profile is studied by this method. (tr-auth)

37930 A SIMPLIFIED NEUTRON ACTIVATION ANALYSIS METHOD FOR COPPER AND MANGANESE. Lofberg, R. T. (Walter Reed Army Inst. of Research, Washington, D. C.); Angel, C. R. Anal. Lett., 2: 239-45(May 1969).

An activation analysis procedure has been developed for the rapid determination of manganese and copper serum values in one milliliter of serum or less with good precision. The sample is irradiated in a neutron flux of 10^{12} cm^{-2} sec^{-1} for two hours followed by nitric acid digestion. The activity plus carrier is adsorbed from saturated lithium chloride solution on Dowex 1-8 contained in a syringe. After washing the resin with more lithium chloride, the syringe is counted in a five-inch-well crystal multichannel spectrometer. The carrier is washed off the syringe by dilute acid and analyzed. The sample concentration is determined by comparison with irradiated standards correcting the unknown for decay and chemical yield. (auth)

37931 YADERNOFIZICHESKIE KONSTANTY DLYA NEITRONNOGO AKTIVATSIONNOGO ANALIZA. SPRAVOCHNIK. (Nuclear-Physical Constants for Neutron Activation Analysis. Handbook). Aliev, A. I.; Drynkin, V. I.; Leipunskaya, D. I.; Kasatkin, V. A. Moscow, Atomizdat, 1969. 329p.

Cross sections for neutron activation analysis by irradiation with thermal neutrons, fission neutrons, and fast neutrons with energies up to 14 MeV are given. Coefficients of self-screening for neutrons of various energy distributions, radioisotope groupings by half-life, and gamma energies are included. Perturbation effects of neutron fields in activation analysis are considered. Graphs of excitation functions for neutron reactions are included. (R.V.J.)

37932 THE DETERMINATION OF LOW $^{235}U/^{238}U$ RATIOS BY ACTIVATION ANALYSIS UTILIZING HIGH RESOLUTION γ SPECTROMETRY. Turkstra, J.; De Wet, W. J. (National Nuclear Research Centre, Pelindaba, S. Afr.). J. S. Afr. Chem. Inst., 22: 1-11(Jan. 1969).

Use of high-resolution γ spectrometry is described for the direct determination of $^{235}U/^{238}U$ isotopic ratios of small U samples (including depleted U), with isotopic ratios below 0.05, after neutron activation. If cooling times of 30 days after reactor irradiation are allowed, the consistency of the γ-spectrometric results relative to mass-spectrometrically analyzed ratios is better than 5% for isotopic ratios between 0.02 and 0.002. A long cooling time improves the ratio of photopeak counts of a chosen fission product to that of a certain photopeak of ^{239}Np, taken as proportional to the $^{235}U/^{238}U$ isotopic ratio of an irradiated U sample. Cooling times longer than 30 days are even more favorable for this method for the isotopic analysis of U samples depleted by more than 0.2% in ^{235}U. The combined photopeak of ^{239}Np (106 keV) and the $K-\alpha_1$ x-ray peak (99 keV) resulting from internal conversion during the decay of ^{239}Np to ^{239}Pu was considered to be the most appropriate for measuring the ^{238}U content of an irradiated sample. This method is a relative method, with the advantage that the weight of U irradiated does not have to be known exactly, in contrast to the use of other activation analysis methods for U isotopic analysis. (BBB)

37933 THE APPLICATION OF NEUTRON ACTIVATION ANALYSIS IN GEOCHEMISTRY. Das, H. A. (Reactor Centrum Nederland, Petten, Netherlands); Sijperda, W. S. Geol. Mijubouw, 47: 395-404(Nov.-Dec. 1968).

Principles of activation analysis are stated and results of determinations in geological samples are compiled. Data are tabulated for analysis of the following elements, giving the radionuclide counted, chemical pretreatment, neutron flux, irradiation time, cooling time, chemical separation procedures, and γ detection equipment used: Na, Mg, Al, Si, P, K, Ca, Sc, Ti, Cr, Mn, Fe, Co, Cu, Zn, Ge, Br, Rb, Sr, Sn, Sb, I, Cs, Ba, Ce, Au, and Th. Advantages and disadvantages of the method are discussed. Since activation analysis permits the determination of both major and trace elements, it is rapidly supplanting classical techniques, such as wet analysis and emission spectrography. It is a convenient method for the simultaneous determination of a large number of elements in small samples. Moreover, the method is very sensitive for most elements. With a thermal neutron flux of 2×10^{13} n cm^{-2} sec^{-1}, the theoretical limit of detection varies from 1 μg to 0.1 pg. For most elements, values in the order of 0.1 to 1 ng are obtainable. (BBB)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 37976, 37988, 38009, 38027, 38039, 38040, 38046, 38084, 38997, 38998, 39014, 39051, 39052, 39057, 39984, 40350, and 40488.

37934 (CEA-R-3704) CONTRIBUTION TO THE STUDY OF URANOVANADATES: PRECIPITATION, STABILITY, AND FILIATION. Nicole, Jacques (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1969. 91p. (In French). Dep.

Thesis.

The interaction of uranyl ions with vanadic anhydride leads to the formation of different uranovanadates according to which uranyl salt is used. With uranyl perchlorate solutions, uranotrimetavanadic acid H $[UO_2(VO_3)_3]$ precipitates, and excess uranyl ions then replace the H to give $UO_2[UO_2(VO_3)_3]_2$. The addition of vanadic anhydride solution leads to the same compounds, although in this case there is prior formation of $UO_2[UO_2(OH)_2VO_3]_2$. Uranyl acetate on the other hand gives successively and quantitatively the acids H $[UO_2(VO_3)_3]$, H $[UO_2(OH)VO_3]$, and H $[UO_2(OH)_2VO_3]$ and then the uranyl salt of this latter compound; the order in which the reagents are added is of no importance. The composition of the uranovanadates obtained by interaction of solutions of uranyl perchlorate and of the various vanadates depends on the ratio Na_2O/V_2O_5 of the vanadates considered. For ratios of less than unity, derivatives of uranotrimetavanadic acid are almost exclusively formed. For ratios equal to 3, the compounds are derivatives of uranometavanadic acid. In between these two ratios, the compounds are derivatives of both acids simultaneously. The changes in these compounds with changing pH confirm these results. (auth)

37935 (RFP-1118) DISSOLUTION OF IMPURE PLUTONIUM TETRAFLUORIDE IN NITRIC ACID. Navratil, James D. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). June 25, 1969. Contract AT(29-1)-1106. 4p. Dep. CFSTI.

Optimum dissolution conditions were found for impure plutonium tetrafluoride (major impurities: PuO_2 and MgO). They are: nitric acid concentration of 12 to 14 molar, reflux and stirring for up to two hours, solid-to-liquid ratio of 100 to 150 g/l, and addition of boric acid or aluminum nitrate. (auth)

37936 (RFP-1151) DISSOLUTION OF PLUTONIUM TETRAFLUORIDE IN NITRIC ACID. Navratil, James D. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). June 25, 1969. Contract AT(29-1)-1106. 5p. Dep. CFSTI.

Optimum conditions for plutonium tetrafluoride dissolution in nitric acid were investigated and found to be solid-to-liquid ratio of 100 to 150 g/l, reflux and stirring for up to 2 hours, nitric acid concentrations of 12 to 14 molar, and addition of boric acid or aluminum nitrate as a fluoride ion complexing agent. (auth)

37937 INTERMEDIATES IN γ-IRRADIATED SOLUTIONS OF CARBON TETRACHLORIDE IN ALKANES AT 77°K. Louwrier, Pieter W. F.; Hamill, William H. (Univ. of Notre Dame, Ind.). J. Phys. Chem., 73: 1702-7(June 1969). (COO-38-636).

Gamma-irradiated samples of CCl_4 in alkane hydrocarbons exhibit optical absorption bands with maxima at 367 and ~470 nm. Isothermal decay of 367-nm absorption and growth of 470-nm absorption and an isosbestic point between these bands provides evidence that one species is the precursor of the other. They are assumed to be CCl_3^- and a CT complex, $CCl_4 \cdot Cl$, resulting from charge recombination with Cl^-. These assignments agree with positive charge migration induced by ~370-nm excitation but not by ~470-nm excitation and by the appearance of the 470-nm band under uv photolysis. (auth)

37938 VAPOR PRESSURE OF PROTACTINIUM(V) CHLORIDE. Weigel, F.; Hoffmann, G.; Ter Meer, N. (Univ., Munich). Radiochim. Acta, 11: 210-14(June 1969). (In German).

The vapor pressure of anhydrous protactinium(V) chloride was measured by means of a pyrex sickle gage in the temperature

range 500 to 600°K. The temperature dependence of the vapor pressure of molten $PaCl_5$ may be described by the equation: ln p (mm Hg) = 17.27 − 7377/T, (1) for the temperature dependence of the vapor pressure of solid $PaCl_5$, the equation ln p (mm Hg) = 23.87 − 11162/T (2) was obtained. Extrapolation of eq. (1) to 760 mm Hg yielded a value of 693°K (= 420°C) for the boiling point of $PaCl_5$. From the vapor pressure data, the following thermodynamic parameters were calculated: entropy of vaporization ΔS_v = 21.1 e.u., heat of vaporization ΔH_v = 14.65 kcal/M entropy of sublimation ΔS_s = 34.2 e.u., and heat of sublimation ΔH_s = 22.17 kcal/M. The Gibbs-Energy at the melting point was calculated to be ΔG_m = 2.4 kcal/M. (auth)

37939 AN ISOTOPE EFFECT STUDY OF THE ACETOLYSES OF SOME TRIPHENYLCARBALKOXYMETHYLPHOSPHONIUM SALTS. Seltzer, Stanley; Tsolis, A.; Denney, Donald B. (Brookhaven National Lab., Upton, N. Y. Rutgers-The State Univ., New Brunswick, N. J.). J. Amer. Chem. Soc., 91: 4236-43(July 16, 1969).

^{13}C and ^{18}O kinetic isotope effects in the carbon dioxide formed during acetolysis of three triphenylcarbalkoxymethylphosphonium salts were determined. Accompanying formation of carbon dioxide from triphenylcarbobenzhydryloxymethylphosphonium bromide (I) were ^{13}C and ^{18}O isotope effects of 1.045 and 1.015, respectively. Triphenylcarbooctyloxymethylphosphonium bromides (II and III) under similar conditions, yielded carbon dioxide attended by no observable isotopic oxygen fractionation and a smaller ^{13}C isotope effect (1.020) than that observed during acetolysis of I. Exact calculations with various transition-state models support solvent-assisted heterolysis of I into benzhydryl carbonium ion, carbon dioxide, and methylenetriphenylphosphorane. Similar considerations lend support to a mechanism whereby II or III in acetic acid–acetic anhydride undergoes rate-controlling acetyl anhydride formation followed by the production of carbon dioxide, triphenylmethylphosphonium bromide, and acetic anhydride. (auth)

37940 METAL ION PROMOTED HYDROLYSIS OF FLUOROCARBONS. Clark, Howell R.; Jones, Mark M. (Vanderbilt Univ., Nashville). J. Amer. Chem. Soc., 91: 4302(July 16, 1969).

The effects of Zr(IV), Th(IV), Ti(IV), Al(III), and Be(II) on the acid hydrolysis of PF_6^-, BF_4^-, $AsF_5(OH)^-$, and benzyl fluoride were studied. Accelerative effects were general, although dependent upon the media and conditions. Data representing quantitative evidence for metal ion catalyzed hydrolytic displacement of fluoride from the C—F linkage are presented. (J.G.B.)

37941 CARBOTHERMIC REDUCTION OF PROTACTINIUM PENTOXIDE AND FIRST RESULTS ON PROTACTINIUM CARBIDE. Lorenz, R. (Technische Univ., Brunswick, Ger.); Scherff, H. L.; Toussaint, N. J. Inorg. Nucl. Chem., 31: 2381-90(Aug. 1969).

The reduction of Pa_2O_5 with carbon was investigated in the temperature range 1000 to 2200°C. As a first step, at about 1100°C, reduction of Pa_2O_5 to PaO_2 occurs, followed by complete reduction to PaC at higher temperatures and reduced pressures. The CO-equilibrium pressures of the reaction: $PaO_2 + 3C = PaC + 2CO$ were determined in the temperature range 1290 to 1440°C. The temperature dependence is given by: $\log P_{co} = 12.07 - 19940/T$ (with P_{co} in torr). The PaC structure was identified from x-ray powder patterns as being identical to those of the other actinide monocarbides (fcc structure, NaCl-type, $a_0 = 5.0608 \pm 0.0002$ Å). At temperatures above 2000°C, and with an excess of free carbon, formation of a higher carbide, probably the dicarbide, PaC_2 could be observed. (auth) (UK)

37942 MECHANISM AND ISOTOPE EFFECT IN AMMONIA SYNTHESIS OVER MOLYBDENUM NITRIDE. Aika, Ken-ichi; Ozaki, Atsumu (Tokyo Inst. of Tech.). J. Catal., 14: 311-21 (Aug. 1969).

The mechanism of ammonia synthesis over molybdenum nitride was studied by means of ^{15}N tracer, deuterium isotope effect, and kinetics. The kinetic data as well as the deuterium isotope effect indicate that the rate-determining step is the chemisorption of nitrogen retarded by adsorbed nitrogen atoms, which is the same situation as concluded with the unpromoted iron. In agreement with this conclusion, it is found that no isotopic mixing takes place in the reactant nitrogen during the synthesis. The subsequent step of the synthesis, i.e., the hydrogenation of the adsorbed nitrogen, is evidently equilibrated. The deuterium isotope effect in the rate of hydrogenation of preadsorbed nitrogen is caused thermodynamically. (auth)

37943 CATALYTIC PROPERTIES OF NON-STOICHIOMETRIC URANIUM–THORIUM MIXED OXIDES IN CARBON MONOXIDE OXIDATION. Claudel, Bernard M.; Brau, Guy G. J. Catal., 14: 322-31(Aug. 1969).

Nonstoichiometric uranium thorium mixed oxides, of general formula $U_xTh_{1-x}O_{2+y}$, have an important catalytic activity in carbon monoxide oxidation between 250 and 350°C. Kinetic study of the reaction is consistent with a mechanism based on oxido-reduction of the catalysts surface. A detailed reaction pattern is proposed and discussed, where oxygen interstitial atoms play the essential role. (auth)

37944 CONTRIBUTION TO THE STUDY OF THE HYDROLYSIS OF TETRAVALENT PLUTONIUM. Metivier, H. (CEA, Paris); Guillaumont, R. Radiochem. Radioanal. Lett., 1: 209-18 (July 1969). (In French).

In order to identify the hydrolysis species of Pu(IV) in a non-complexing medium, the distribution was studied in the system $HClO_4$–$LiClO_4$, μ = 1, TTA–benzene, for concentration ranges from 10^{-6} (^{238}Pu) to 10^{-4} M (^{239}Pu). The acidity was varied between 10^{-3} and 1 N. The stability conditions of tetravalent state of plutonium in this system were defined and then the variation of distribution coefficient of Pu(IV) as a function of acidity and TTA concentration in organic phase was established. The data make it possible to calculate the first and second hydrolysis constants of Pu^{4+} ion. (auth)

37945 PROBABLE CHEMICAL PROPERTIES OF THE ELEMENT 114. Joergensen, C. K. (Univ., Geneva); Haissinsky, M. Radiochem. Radioanal. Lett., 1: 181-4(July 1969). (In French).

The comparison of the evolution of the chemical properties of the b-subgroups in the Periodic Table makes it possible to predict some of the properties of eka-lead (Z = 114) with reasonable certainty. (auth)

37946 APPLICATION OF THE STATISTICAL PHASE SPACE THEORY TO REACTIONS OF ATOMIC HYDROGEN WITH DEUTERIUM HALIDES. Truhlar, Donald G.; Kuppermann, Aron (California Inst. of Tech., Pasadena). J. Phys. Chem., 73: 1722-34(June 1969). (CALT-532-29).

A statistical phase space theory of chemical kinetics, developed by Light, Pechukas, and Nikitin, is used to predict the reaction cross sections and rates of the processes H + AB → HA + B and HB + A, where AB = DCl, DBr, DI, and HI. The theory contains no adjustable parameters and agreement with experiment for the abstraction fraction [HA]/([HA] + [HB]) is fair. The predicted rates are too large, indicating that the statistical assumption is not completely valid. The predicted dependence of the reaction probabilities on initial orbital angular momentum and the predicted internal energy distributions of the products are also presented and discussed. For AB = DI, the prediction for the fraction of I atoms produced in the $^2P_{\frac{1}{2}}$ electronically excited state is in disagreement with recent experiments. (auth)

37947 RADIOCHEMICAL STUDY OF SELF-DIFFUSION AND ISOTOPE EXCHANGE IN AQUEOUS SOLUTIONS. PART I. SELF-DIFFUSION OF Tl(I) AND Tl(III) IONS IN A PERCHLORIC ACID MEDIUM. Gosman, Alexandr; Sedlacek, Josef (Technical Univ., Prague). Radiochim. Acta, 11: 112-17(Apr. 1969).

A continuous scintillation method for measuring self-diffusion was used in investigating the dependence of Tl^+ and Tl^{3+} ion self-diffusion coefficients on the concentration of perchloric acid both in $HClO_4$ and $HClO_4 + NaClO_4$ solutions. The efficiency of the scintillator and also the possible approach to interpretation of the values of D with respect to viscosity and solution concentration are discussed. (auth)

37948 MEDIATION OF A PRIMARY KINETIC ISOTOPE EFFECT BY ASYMMETRIC INDUCTION. Morrison, James D.; Ridgway, Robert W. (Univ. of New Hampshire, Durham). J. Amer. Chem. Soc., 91: 4601-2(July 30, 1969).

Deuterium-labeling experiments were used to study the mechanistic details of the reduction of tert-butyl phenyl ketone with Grignard reagents. It was observed that C-3 chiral center in diastereomeric Grignard reagents from 1-chloro-2,3-dideuterio-3-phenylbutane mediates a primary isotope effect (k_H/k_D), which is "normally" in the range of 2 to 3, so that, depending upon which diastereomer of labeled Grignard reagent is used, an unusually large or an inverse isotope effect may be obtained for the reduction of tert-butyl phenyl ketone. The results demonstrate that significant transition-state energy differences may be observed for reaction of compounds which are epimeric only by virtue of an isotopic disparity at one chiral center. (D.H.M.)

37949 ON γ-DEUTERIUM ISOTOPE EFFECTS IN NORBORNYL SYSTEMS. Goering, Harlan L.; Humski, Kresimir (Univ. of Wisconsin, Madison). J. Amer. Chem. Soc., 91: 4594-5 (July 30, 1969).

The γ isotope effect was investigated in an exo-norbornyl system

which is known to involve unassisted ionization. The rates of solvolysis of 1,2-dimethyl-exo-2-norbornyl nitrobenzoate and the 6,6-dideuterio ester in 90% aqueous acetone were compared. Results show that the γ isotope effect for two C-6 deuterium atoms in the tertiary exo-norbornyl system is barely detectable; this is in sharp contrast to the remarkable isotope effect for one deuterium atom in the parent exo-norbornyl system ($k_H/k_D = 1.02$ vs 1.10) (D.H.M.)

37950 DEUTERIUM AS AN AROMATIC SUBSTITUENT. FLUORINE CHEMICAL SHIFTS IN THE MONODEUTERIOFLUOROBENZENES. Young, William R.; Yannoni, Costantino S. (IBM Thomas J. Watson Research Center, Yorktown Heights, N. Y.). J. Amer. Chem. Soc., 91: 4581-2(July 30, 1969).

The magnitude of the isotopic shifts for monodeuteriofluorobenzene vary markedly with deuterium position. The effect of an ortho deuterium is 25 and 35 times that of para and meta deuterium, respectively. It appears that an ortho deuterium creates an abnormally large isotope effect on the ^{19}F chemical shift. (D.H.M.)

37951 MECHANISMS OF ELIMINATION REACTIONS. XII. HYDROGEN ISOTOPE EFFECTS AND THE NATURE OF THE TRANSITION STATE IN ELIMINATIONS FROM ALICYCLIC QUATERNARY AMMONIUM SALTS. Saunders, William H. Jr.; Ashe, Thomas A. (Univ. of Rochester, N. Y.). J. Amer. Chem. Soc., 91: 4473-8(July 30, 1969).

trans-Cyclohexyl-2-d-trimethylammonium, trans-cyclopentyl-2-d-trimethylammonium, and 3-pentyl-2,2-d_2-trimethylammonium p-toluenesulfonates were prepared. Intramolecular isotope effects were determined for their base-promoted decomposition by measuring the deuterium contents of the product olefins in the mass spectrometer. With hydroxide ion in water at 191°C, k_H/k_D ran cyclohexyl, 4.33; cyclopentyl, 3.99, 3-pentyl, 3.22. The latter two compounds were also run in ethoxide–ethanol, isopropoxide–isopropyl alcohol, and t-butoxide–t-butyl alcohol. In all cases, k_H/k_D was larger for cyclopentyl than for 3-pentyl. Kinetics and products were determined for the undeuterated compounds and rates of elimination calculated. The cyclohexyltrimethylammonium salt reacted more slowly than the other two under all conditions. These results are consistent with an explanation previously advanced for Saytzev-rule products from cyclic quaternary ammonium salts. Steric strain is assumed to make the carbon–nitrogen bond easier to break in the cyclic reactants, necessitating less assistance from concomitant carbon–hydrogen cleavage. This results in an extent of hydrogen transfer in the transition state in the order 3-pentyl > cyclopentyl > cyclohexyl. Evidence is adduced that syn elimination is probably not a significant complication in the interpretation of results. (auth)

37952 MECHANISMS OF ELIMINATION REACTIONS. XI. THEORETICAL CALCULATIONS OF ISOTOPE EFFECTS IN ELIMINATION REACTIONS. Katz, Arthur M.; Saunders, William H. Jr. (Univ. of Rochester, N. Y.). J. Amer. Chem. Soc., 91: 4469-72(July 30, 1969).

Deuterium and sulfur isotope effects were calculated for E2 reactions of hydroxide ion with ethyldimethylsulfonium ion, using the Wolfsberg–Schachtschneider FG matrix program. The dependence of the isotope effects on transition-state force constants (including off-diagonal F matrix elements used to achieve a zero or imaginary reaction coordinate frequency) was explored. The deuterium isotope effect goes through a maximum when the proton is half-transferred, and is not strongly affected by the extent of weakening of the carbon–sulfur bond. Similarly, the sulfur isotope effect increases with increasing extent of carbon–sulfur bond weakening, and does not depend much on the extent of proton transfer. Less reassuring are two other observations. The deuterium isotope effect can be changed drastically by changes in the degree of coupling (off-diagonal F matrix elements) of the proton-transfer motion with other atomic motions, and the sulfur isotope effect can remain very small until the stretching force constant of the carbon–sulfur bond has decreased to less than half of its original value. The implications of these results for the use of isotope effects in determining transition-state structures are discussed. (auth)

37953 ELECTRON SPIN RESONANCE STUDIES OF HYDROXYSEMIQUINONE RADICALS. HYDROGEN–DEUTERIUM ISOTOPE EFFECTS IN INTRAMOLECULAR HYDROGEN BONDS. Gendell, Julien; Miller, William R. Jr.; Fraenkel, George K. (Columbia Univ., New York). J. Amer. Chem. Soc., 91: 4369-80(July 30, 1969).

Electron spin resonance spectra were obtained of semiquinone radicals containing intramolecular hydrogen bonds produced by reduction of 1,4-dihydroxy-5,8-naphthoquinone, 1,4-dihydroxy-, 1,5-dihydroxy-, and 1,8-dihydroxy-9,10-anthraquinone, and 6,11-dihydroxy-5,12-tetracenequinone. The same radicals were also investigated with the hydrogen in the hydroxyl position replaced by deuterium. Some of the species were studied in several different solvent systems, and some over a wide temperature range. The proton–deuteron splitting-constant ratios for the protons and deuterons in the hydroxyl positions were found to have values ranging from $(a^H_{OH}/a^D_{OD}) = 7.2$ to 7.8 instead of the value of $(a^H/a^D) = 6.514$ predicted solely on the basis of the magnetic properties of the two isotopes. Substitution of deuterium for hydrogen in the hydroxyl positions was also found to cause significant changes in the ring-proton splitting constants. These two isotope effects were correlated with changes in the π-electron spin-density distribution determined by the Hückel molecular orbital method. In these calculations, the value of the Coulomb integral for the oxygen atom in the deuterated radicals was chosen to be more negative than the value for the undeuterated species. The deuterium isotope effects in hydrocarbon radicals cannot be accounted for in this way, and the different interpretations are attributed to differences between the structure of carbon–hydrogen bonds and intramolecular hydrogen bonds. An attempt to correlate the hydroxyl-proton splittings with calculated spin densities on the oxygen atoms was not on the whole successful, and the detailed analysis suggests that the $\sigma-\pi$ parameters for an intramolecular hydrogen bond vary from radical to radical, and with the solvent employed to study a particular radical, because the structure of these bonds is extremely sensitive to the surroundings. A tentative assignment of the proton splitting constants previously reported for the 1,4-dihydroxyanthrasemiquinone ion was shown to be incorrect. (auth)

37954 CHEMICAL CONSEQUENCES OF THE $^{193}Os(\beta^-)^{193}Ir$ DECAY IN OSMIUM COMPOUNDS STUDIED BY THE MOESSBAUER METHOD. Rother, P.; Wagner, F.; Zahn, Ursel (Technische Hochschule, Munich). Radiochim. Acta, 11: 203-10(June 1969).

The chemical consequences of the β^- decay of ^{193}Os in osmium compounds were studied by the recoilless resonance absorption of the 73 keV γ-rays of ^{193}Ir. Isomer shift data were used to attribute different charge states to the prominent lines observed in the Moessbauer emission spectra. In OsO_4, $K_2OsO_4 \cdot 2\,H_2O$ and $Os(C_5H_5)_2$ the β^- decay of ^{193}Os leads to Ir entities, which are isoelectronic with the parent compounds. In the Os(IV) hexahalides, however, Ir(IV), Ir(III) and, possibly, Ir(II) were observed, indicating a fast electronic recombination mechanism. The influence of the $^{192}Os(n,\gamma)^{193}Os$ reaction and of subsequent annealing was found not to change the emission patterns fundamentally. (auth)

37955 THE CHEMISTRY OF CERIUM IN OXIDE SYSTEMS: INVESTIGATION OF THE EFFECT OF TEMPERATURE AND GASEOUS ENVIRONMENT ON SOLID-PHASE REACTIONS. Leonov, A. I.; Andreeva, A. B.; Shvaiko-Shvaikovskii, V. E.; Keler, E. K. pp 99-103 of Chemistry of High-Temperature Materials. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969.

From 2nd All-Union Conference on the High-Temperature Chemistry of Oxides, Leningrad, USSR. See CONF-651160.

Trivalent cerium exists in compounds with other oxides as an analog of the lanthanides and forms numerous compounds: silicates, titanates, aluminates, the chromite, the gallate, niobates, tantalates, and many others. It was established that the thermodynamic stability of cerium increases when these compounds form solid solutions with analogous compounds of other rare earths. Because of these properties, cerium occurs in the trivalent state in many natural minerals. Cerium oxides of both the tri- and tetravalent state form solid solutions with ZrO_2, depending on the oxygen partial pressure of the gaseous phase. Tetravalent cerium usually interacts with oxides of large ionic radius—as, for example, the lanthanide and alkaline-earth oxides (CaO, SrO, BaO), where CeO_2 forms limited solid solutions as well as a compound of the type $A^{2+}B^{4+}O_3$. (auth)

37956 CHRONOPOTENTIOMETRIC STUDY OF THE REACTION $Np(III) \rightarrow Np(IV) + e^-$ IN MOLTEN LiCl–KCl EUTECTIC. Martinot, L.; Duyckaerts, G. (Lab. of Nuclear Chemistry, Liege). Anal. Lett., 1: 669-78(1968).

A chronopotentiometric study of the reaction $Np(III) \rightarrow Np(IV) + e^-$ in molten LiCl–KCl is reported. The diffusion coefficient of Np(III) increases from 4.6×10^{-6} to 26.9×10^{-6} cm^2/sec when the temperature increases from 400 to 650°C. The mechanism of the diffusion is discussed and some aspects of the kinetics of the reaction are also clarified. (auth)

37957 THEORETICAL CONCEPTS FOR HIGH TEMPERATURE TERNARY MOLTEN SYSTEMS AND THEIR IMPLICATIONS IN PYROMETALLURGICAL PROCESSES. Blander, Milton; Hagemark, Kjell (North American Rockwell Corp., Thousand Oaks, Calif.). Nucl. Met., Met. Soc. AIME, 15: 579-616(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Fundamental theories of ternary systems are reviewed with a discussion of the similarities and differences between ternary reciprocal systems ($A^+,B^+/X^-,Y^-$), additive ternary systems (A^+, $B^+,C^+/X^-$), and metallic systems. In dilute solutions of two components one may define association constants between pairs of ions in terms of fundamental energy parameters. In concentrated solutions, deviations from ideal solution behavior are related to nonrandom mixing. Theoretical criteria for the prediction of phase diagram behavior, solubilities, extraction behavior, liquid-liquid miscibility, and other thermodynamic properties important in pyrometallurgical processing will be presented for simple systems. (auth)

37958 CHEMISTRY AND THERMODYNAMICS OF MOLTEN SALT REACTOR FUELS. Baes, C. F. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Met., Met. Soc. AIME, 15: 617-44(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

The chemical development carried out in support of the Molten Salt Breeder Reactor (MSBR) concept has produced a fairly quantitative description of the chemistry and thermodynamics of actinide, fission product, and structural metal fluorides in molten $LiF-BeF_2$ solutions. This information is summarized here (1) in terms of important heterogeneous chemical equilibria, many of which have been measured directly; (2) in terms of free energies of formation of solutes in molten 0.67 $LiF-0.33$ BeF_2 solutions; and (3) in terms of standard electrode potentials, some of which were measured directly. This information may be applied to a variety of important aspects of molten salt reactor chemistry: The extent of corrosion reactions between the container material, Hastelloy N, and the fuel can be specified from hydrogen reduction equilibria. Salt purification procedures can be specified for the removal of structural metal cations, oxides, and sulfides from a knowledge of the hydrofluorination equilibria which are employed. The stability of Th, Pa, and U fluorides toward chemical reduction and toward precipitation as oxide similarly were established by measurements of heterogeneous equilibria that include oxide solubility and oxide exchange reactions. The behavior of a large part of the yield of fission products can also be predicted on the basis of these studies and available thermochemical data. Finally, the chemical studies reviewed here and the thermodynamic information that they produced suggest the importance of the redox potential, determined by the extent of reduction of UF_4 to UF_3 in the fuel, in controlling many features of MSBR fuel chemistry. (auth)

37959 MASS TRANSFER AND TRANSPORT PROPERTIES IN FUSED SALT AND LIQUID METAL SYSTEMS. Olander, D. R. (Univ. of California, Berkeley); Pasternak, A. D. Nucl. Met., Met. Soc. AIME, 15: 467-510(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

The relevance of fundamental mass transfer studies of high-temperature inorganic liquid–liquid extraction systems to the design of pyrochemical reprocessing contactors is discussed. Particular attention is paid to the applicability of theoretical models and correlations developed from low temperature aqueous–organic systems to liquid metals and fused salts. The measurement and prediction of viscosities and diffusivities in liquid metals are reviewed. (auth)

37960 USE OF ZIRCONIUM IN THE CHEMICAL INDUSTRY. Elchardus, E. Ind. Chim. Belge, 32: Special No., (Vol. 2), 269-75(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.2).

The uses of zirconium in the chemical industry are very limited. This is due, to some extent, to the price of the metal and to the possibilities of supply. Several special cases in which the use of zirconium would be more interesting than that of titanium are examined. (tr-auth)

37961 QUENCHING OF THE FLUORESCENCE OF URANYL CHLORIDE BY URANIUM TETRACHLORIDE. Sevchenko, A. N.; Skutov, I. K.; Umreiko, D. S. (Belorussian State Univ., Minsk). Dokl. Akad. Nauk BSSR, 13: 306-8(Apr. 1969). (In Russian).

Measurements were made of the spectra, the average lifetime of excited states, and relative luminescence of aqueous solutions of uranyl chloride with additions of different amounts of UCl_4 at 77°K. On the basis of the character of change and the immutability of the luminescence spectra, a premise was made concerning the resonant migration of energy from excited molecules of uranyl compounds to uranium compounds. (tr-auth)

37962 TO THE CHEMISTRY OF ANDERSONITE AND THERMAL DECOMPOSITION OF DIOXO-TRICARBONATOURANATES. Cejka, J. (Chemical and Metallurgical Production Corp., Roudnice, Czech.). Collect. Czech. Chem. Commun., 34: 1635-56(June 1969).

The preparation of andersonite, sodium dioxo-tricarbonatouranate $Na_2Ca[UO_2(CO_3)_3] \cdot 6\ H_2O$, by free crystallization from aqueous solution at pH 6.5 is described. Its water solubility at 20°C is compared with that of chemically related dioxo-tricarbonatouranates. Conditions of the formation of andersonite in nature are discussed. On the basis of investigations involving thermal decomposition of uranyl carbonate, sodium, calcium, and sodium calcium dioxo-tricarbonatouranates by DTA, TGA, isothermal heating, chemical and phase analyses, and making use of a study of the systems $UO_3-2\ Na_2CO_3$, $UO_3-2\ CaCO_3$, $UO_3-Na_2CO_3-CaCO_3$, a scheme for the thermal decomposition of uranyl carbonate as well as of the above-mentioned dioxotricarbonatouranates is suggested. (auth)

37963 CARBONATO COMPLEXES OF TRIVALENT AMERICIUM AS WELL AS TETRA- AND HEXAVALENT URANIUM AND PLUTONIUM. Keller, C.; Fang, D. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 11: 123-7(June 1969). (In German).

The electrochemical reduction of U(VI) and Pu(VI) in a solution of alkali carbonate gave rise to the formation of carbonato complexes of U(IV) and Pu(IV); both complexes being present in the same solution. At elevated temperatures these carbonato complexes decomposed giving a white homogeneous precipitate of $(U,Pu)O_2 \cdot aq$ having a O:Me ratio slightly above 2. The previous U:Pu ratio did not change during the reduction and precipitation process. The thermal decomposition of americium(III) carbonate, $Am_2(CO_3)_3 \cdot 4\ H_2O$, and the double carbonates $Na[Am(CO_3)_2] \cdot 4\ H_2O$ and $Na_3[Am(CO_3)_3] \cdot 3\ H_2O$ always yields AmO_2 as final product although different intermediate steps are involved: $Am_2(CO_3)_3 \cdot 4\ H_2O \rightarrow Am_2(CO_3)_3 \rightarrow Am_2O(CO_3)_2 \rightarrow Am_2O_2(CO_3)_2 \rightarrow AmO_2$; $Na[Am(CO_3)_2] \cdot 4\ H_2O \rightarrow Na[Am(CO_3)_2] \cdot 3\ H_2O \rightarrow Na[Am(CO_3)_2] \rightarrow Na[AmO_{1.5}CO_3] \rightarrow AmO_2 + 1/2\ Na_2CO_3$; $Na_3[Am(CO_3)_3] \cdot 3\ H_2O \rightarrow Na_3[Am(CO_3)_3] \rightarrow AmO_2 + 3/2 \cdot Na_2CO_3$. U(VI) was extracted from 0.1 to 1 M Na_2CO_3 solution as tricarbonatodioxouranium(VI) anion using trialkylmethylammonium chloride (Aliquat-336). (auth)

37964 KINETICS OF REACTION OF NIOBIUM WITH XYLENOL ORANGE. Morgen, E. A.; Vlasov, N. A. (Irkutsk State Univ., USSR). Zh. Anal. Khim., 24: 1027-30(July 1969). (In Russian).

The composition of the niobium(V) complex with Xylenol Orange and the kinetics of their reaction at 20, 25, and 35°C have been studied photometrically. At a certain pH and the metal excess niobium(V) and Xylenol Orange react at a ratio of 1:1. The reaction proceeds by the first order with respect to Xylenol Orange. The reaction rate constants and the activation energy have been determined. (auth)

37965 STRUCTURE AND SPECTRO-LUMINESCENCE PROPERTIES OF URANYL NITRATE COMPLEXES WITH DIPYRIDYL. Kopashova, I. M.; Umreiko, D. S.; Shamanovskaya, R. I. Zh. Prikl. Spektrosk., 10: 675-8(Apr. 1969). (In Russian).

Energy transfer paths of complexes of UO_2^{2+} with its coordinated ligands were studied, attempting to resolve the problems of vibrations, luminescence, and the structure of the complex. The following complexes of uranyl nitrate with dipyridyl were used in the investigation: $UO_2(NO_3)_2 \cdot Dip$; $UO_2(NO_3)_2\ Dip \cdot 4H_2O$; and $Dip_2[UO_2(NO_3)_4]$. The single crystals were grown by free evaporation of the solution at 22°C; infrared absorption was determined spectrophotometrically in the 400 to 3600 cm^{-1} region, and luminescence was recorded by spectrophotography. On the basis of the relatively weak donor–acceptor bond between the uranyl group and the dipyridyl molecules, and the data obtained, it was concluded that it is improbable that the vibration energy exchange between UO_2^{2+} and CH groups follow the laws of elastic forces. Quite probably, the interaction and collectivization of the electron shells of the complex are responsible for the frequency of the CH vibrations in the fluorescence spectra. This interaction does not lead to a strong deactivation of the vibration energy of electron excitation, as it occurs in chemical bonds. (TTT)

37966 THE RULES OF THE THERMODYNAMICS OF ISOTOPIC EXCHANGE. VI. LINEAR AND NONLINEAR MOLECULES XY_2 AND OCTAHEDRAL MOLECULES XY_6. Knyazev, D. A.; Ivlev, A. A.; Popov, I. B. (Moscow Chemical-Technological Inst.). Zh. Fiz. Khim., 43: 1269-78(May 1969). (In Russian).

The beta factors for 66 linear molecules XY_2, 32 nonlinear molecules XY_2, and 26 octahedral hexahalogenides XY_6 (including

UF_6, NpF_6, PuF_6, and TcF_6) were estimated. Correlation ratios were used for fitting quantities of β_x and for estimating β_x factors of 68 molecules. Certain rules were studied connecting beta factors in a series of related compounds. It was found that the character of these rules depends essentially on the type of symmetry of the molecules. (tr-auth)

37967 ANOMALOUS TEMPERATURE DEPENDENCE OF KINETIC CARBON ISOTOPE EFFECTS AND THE PHENOMENON OF CROSSOVER. Huang, Thomas T.-S; Kass, William J.; Buddenbaum, Warren E.; Yankwich, Peter E. (Univ. of Illinois, Urbana). Contract AT(11-1)-1142. J. Phys. Chem., 72: 4431-46(Dec. 1968). (COO-1142-78).

The effects of diagonal and off-diagonal stretching force constant variations on the temperature-dependent and temperature-independent factors in the intramolecular isotopic rate constant ratio for the decomposition of ^{13}C-labeled oxalic acid were explored. Crossover (change in sense with respect to unity) of the temperature-dependent factor is not observed when the reaction coordinate consists of a single internal coordinate displacement. When a zero frequency is achieved by employing one large off-diagonal force constant (two elements in the reaction coordinate), crossover is observed only if the basic diagonal force field is asymmetric at one or more isotopic bonds. If the reaction coordinate contains three or more elements (two or more nonzero off-diagonal force constants are employed), anomalies of temperature dependence can be generated with symmetric diagonal force fields. Two new techniques for study of the effects of systematic variation of the composition of the reaction coordinate were introduced and/or applied. (auth)

37968 SELECTIVE URANYL NITRATE PERMEATION THROUGH PLASTICIZED POLY(VINYL CHLORIDE) MEMBRANES: CORRELATION OF FLUXES WITH COMPLEXATION RATES. Vofsi, D.; Kedem, D.; Bloch, R.; Marian, S. (Weizmann Inst. of Science, Rehovoth, Israel). J. Inorg. Nucl. Chem., 31: 2631-4(Aug. 1969).

The selective permeation of uranyl nitrate through a tributyl phosphate-plasticized polyvinyl chloride membrane was described in Ind and Engng Chem. Process Design and Development 6: 231 (1967). In a search for uranyl nitrate transporting materials of improved plasticizing performance, membranes were prepared containing dibutylcresyl and dicresylbutyl phosphate-plasticized PVC compositions. Measurements of UN permeation showed that contrary to previous assumptions, relative transport rates through these solvent-media are not determined by the distribution coefficients of solute between membrane and aqueous phases. The results show that the diffusion velocity of the solute in the membranes is very sensitive to changes in the chemical nature of the active plasticizer. Evidence was found for a correlation between membrane transport and the kinetics of complex formation between transported species and membrane matrix. It was concluded that separations may be achieved by means of membranes that would be difficult or impossible when the same systems are used in equilibrium extraction. (UK)

37969 EQUATION OF STATE OF ISOTOPIC ETHYLENE. Dorfmueller, Th.; Goepel, W. (Technische Univ., Hanover). Z. Naturforsch., 24a: 852-4(May 1969). (In German).

The second virial coefficients of C_2H_4 and C_2D_4 were measured at 236.04°K. The experimental isotope effect of 1.07% can be separated into one contribution from a translational quantum effect and one contribution that is due to the different molar volumes of the isotopes. In this temperature region the isotope effect is shown to be mainly a volume effect. This explanation is confirmed by results from molar volume measurements of the liquid isotopes. (auth)

37970 POSSIBILITY OF THE MIGRATION OF THE REACTION CENTER DURING THE DEUTERODEMERCURIZATION OF DIBENZYLMERCURY. Beletskaya, I. P.; Fedorov, L. A.; Reutov, O. A. (Lomonosov State Univ., Moscow). Zh. Org. Khim., 3: 225-30(Feb. 1967). (In Russian).

Entrance of D into the benzene ring was studied during protolysis of dibenzylmercury (DBM) in DCl. Since the C–Hg bond in DBM is quite polar and the protodemercurization reaction proceeds through an intermediate ion pair formation, delocalization of the electron density can be expected, as a result of which a migration of the reaction center during the reaction of DBM is possible. By use of DCl instead of HCl, it was observed that in various solvents differing polarity (acetonitrile, dimethylformamide (DMF), dimethylsulfoxide (DMSO), and dioxane) the DCl attack proceeds not only at the α position but also in the ortho and para positions of the DBM benzene rings, i.e., in sites with excess electron density. The reaction conditions were varied in acetonitrile. The deuterodemercurization was carried out with aqueous DCl to suppress the possible protonic dilution of the medium by liberating protons in the course of the reaction. The toluenes formed were isolated and analyzed by high resolution PMR spectroscopy, ir spectroscopy, and mass spectrometry. On the basis of the ir and mass spectra of the products isolated during deuterodemercurization of DBM, it was concluded that they evidently contain not less than 6 individual toluenes. Kinetics of the proto(deutero) demercurization of DBM indicated that the first (slow) step of this reaction is the ionization of the DMB molecule with the formation of an ion pair and partial delocalization of the electron density along the ring. From the data on deuterodemercurization of DMB in various solvents, it followed that the subsequent fast attack by the DCl molecule can proceed not only at the α-position, but also in the ortho and para positions of the aromatic ring in the DBM molecule from which, evidently, unstable structures are formed, which, by reacting at the α position with a second DCl (HCl) molecule, are stabilized with the formation of dideuterotoluenes (α, o- or α,p-D_2-toluene). As a result of the delocalization of the electron density between the α position and the aromatic ring of DBM during its reaction with DCl, not less than 20 to 40% D enters the aromatic ring during the reaction along with a migration of the reaction center. (BBB)

37971 ENRICHMENT OF THE HEAVY CARBON ISOTOPE BY COUNTER-CURRENT ELECTROLYSIS. IX. CONTRIBUTIONS ON COUNTER-CURRENT ELECTROLYSIS. Thiemann, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch., 24a: 830-5(May 1969). (In German).

The isotope effect of ^{14}C on the electromigration properties of formate, oxalate, and methylammonium ions was investigated, using a countercurrent electromigration column. The isotope effect depends on the composition and concentration of the electrolyte and varies between 0.001 and 0.009. Obviously, it is a superposition of kinetic and equilibrium isotope effects. Some consequences on the mechanism of isotope effects of molecular ions are discussed. (auth)

37972 ENERGY TRANSFER IN URANYL PHOSPHATE LIQUIDS AND GLASSES. Agabekyan, A. S.; Zhabotinskii, M. E. Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 387-94(1968). (In Russian).

Energy transfer in uranyl phosphate liquids and glasses is investigated. The matrix element of interaction that results in transfer of excitation between ions is estimated. The treated model is in good agreement with the experimental data. (auth)

37973 THE METAVANADATE OF NEPTUNIUM(IV): $Np(VO_3)_4$. Pages, Monique; Freundlich, William (Institut de Physique Nucleaire, Paris). Compt. Rend., Ser. C, 263: 2181-3(June 23, 1969). (In French).

A metavanadate of neptunium(IV), $Np(VO_3)_4$, with tetragonal symmetry was isolated in the form of monocrystals. It is isotypic with the metavanadate of thorium, $Th(VO_3)_4$. The unit cell parameters are: a = 11.88 and c = 28.36 for $Np(VO_3)_4$ and a = 12.08 and c = 28.92 for $Th(VO_3)_4$. (tr-auth)

37974 ISOTOPIC EXCHANGE OF HYDROGEN IN HEXASUBSTITUTED BENZENE DERIVATIVES. Ginzburg, A. G.; Setkina, V. N.; Kursanov, D. N. (Inst. of Heteroorganic Compounds, Moscow). Zh. Org. Khim., 3: 1921-5(Nov. 1967). (In Russian).

It was shown that 1, 2, 3, 4, 5, 6, 7, 8-octahydro-9, 10-dimethylphenanthrene, 1, 2, 3, 4-tetrahydro-5, 6, 7, 8-tetramethylnaphthalene, and other hydrocarbons containing a cyclopentane or cyclohexane ring condensed with benzene undergo H–D exchange with acids (D_2SO_4 and DCl + $FeCl_3$ in a medium of $C_6H_5NO_2$, anhydrous CF_3COOD). Under these conditions hexamethylbenzene and hexaethylbenzene do not undergo exchange. The PMR spectrum indicated that only hydrogen atoms of the β–CH_2 groups of the cycloalkane rings exchange. To establish whether the ability for H–D exchange with acids is retained by the β–CH_2 groups of the condensed cycloalkane ring when the free positions in the benzene ring contain substituents other than methyl groups, studies were conducted with 9,10-dibromo-1,2,3,4,5,6,7,8-octahydrophenanthrene and 1,2,3,4-tetrachloro-5,6,7,8-tetrahydroanaphthalene with D_2SO_4 in $C_6H_5NO_2$. It was found that the replacement of the methyl groups in the benzene ring by halogen atoms leads to the total suppression of H–D exchange reaction of the β–CH_2 groups. These two compounds do not undergo H–D exchange even under much more severe conditions of temperature, acidity, and reaction time than those used for the first two compounds. The inhibiting effect of electron-donor substituents is in accord with the view that the isotopic exchange reaction is associated with the formation of a carbonium center in the side chain. Hexaethylbenzene underwent H–D exchange with D_2SO_4 in a medium of CF_3COOD + CCl_4 at 40 to 50°. The β-position was the site of H–D exchange. (BBB)

37975 CONTRIBUTION TO THE STUDY OF URANIMOLYBDATES IN AQUEOUS SOLUTION. Prevost, Henri (Faculte des Sciences, Lille). Chim. Anal. (Paris), 51: 140-1(Mar, 1969). (In French).

Addition of $UO_2(ClO_4)_2$ to a solution of MoO_3 produces a uranimolybdic acid with the formation of hydronium ions; the inverse addition produces the same result eventually, but with preliminary precipitation of an acid of different composition. The compounds obtained depend strongly on the pH of the molybdate solution: one set of products is obtained uniformly from tetramolybdate, paramolybdate, and bimolybdate, and can be rationalized by hydrolysis of the UO_2^{2+} ion followed by reaction of the molybdate; another set is obtained by reaction with neutral Na molybdate. The ions obtained were $UO_2(MoO_4)_4^{6-}$, $UO_2(MoO_4)_3^{4-}$, $UO_2(MoO_4)_2^{2-}$, $(UO_2OH)(MoO_4)_2^{3-}$, and $(UO_2OH)(MoO_4)^{-}$. These may be compared to the known series of sulfate complexes of uranyl ion; there are striking parallelisms, though no evidence could be gathered for the existence of UO_2MoO_4, corresponding to UO_2SO_4. The new compounds were studied by potentiometry, conductimetry, spectrophotometry, chemical analysis, and radiocrystallographic analysis. (BBB)

Radiation and Nuclear Chemistry

Refer also to abstracts 38068, 38182, 38775, 39592, and 40416.

37976 (AE-360) NUCLEAR CHEMISTRY PROGRESS REPORT 1968. Carleson, Goeran (ed.) (Aktiebolaget Atomenergi, Stockholm (Sweden)). May 1969. 37p. Dep.

The systematic investigation of phase diagrams of inorganic salts in light and heavy water at medium and low temperature has proceeded according to plan. Solubilities were determined mainly for alkali and alkaline earth metal halides. A connection between solubilities and water structure in the salt solutions formed was observed. Spectra of H and OH radicals as well as other transients were recorded, and their rate constants determined by a pulse-radiolytic technique in aqueous solutions of aniline and other admixtures. Trapped electrons and OH radicals are being studied with the same technique in H_2O ice and D_2O ice at various temperatures. Decay kinetics and G values were calculated. Aqueous solutions of benzene and toluene were also investigated after gamma radiolysis. The radioinduced polymerization in single crystals of vinyl monomers is being studied by means of ESR technique. Evidence for radical pair formation was observed. X-ray diffraction analysis is used to determine the crystal structures, thereby contributing to a more complete interpretation of the ESR spectra. The polymerization efficiency as well as the formation of grafting and homopolymers in wood-polymer combinations between native Scandinavian woods and vinyl of/and polyester monomers were studied as a function of total dose, dose rate, diluting agents, and humidity. Erratic reproducibility was observed for the pine-methyl methacrylate system, which makes this material less useful in industrial applications. Neutron and photonuclear activation analysis, partly in combination with a low temperature technique, were used to determine micro amounts of iodine and some other elements in pharmaceuticals and biological tissue. A special geometrical arrangement was adapted for multiple sample irradiation. Methods for the preparation of inorganic ion exchangers of zirconium phosphate with a very low phosphate leakage even at high temperatures were discovered. The crystallinity of the resin was found to have a profound influence and was studied in detail. Zirconium hydroxide gels were also prepared and their affinities towards various anions studied. An investigation of the radiation stability of inorganic ion exchangers in the dose range 1 to 10^5 Mrads has recently started. A cardiac pacemaker prototype powered by an isotopic battery is being developed and manufactured. Various design parameters and gamma sterilization problems were studied. (auth) (Sweden)

37977 (ORNL-4351) RADIATION CHEMICAL STUDY OF PLASTICS FOR CHARGED PARTICLE TRACK REGISTRATION. Pt. A. RADIATION CHEMISTRY OF CELLULOSIC CHARGED PARTICLE TRACK DETECTORS. Pt. B. POSSIBLE METHODS OF ALPHA PARTICLE TRACK REGISTRATION WITH POLYTETRAFLUOROETHYLENE. Sears, D. R.; Bopp, C. D. (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 35p. Dep. CFSTI.

A radiation chemical investigation was performed on cellulose derivatives used for charged particle track registration. Studies of the radioinduced decomposition of cellulose and cellulose acetate, triacetate, and dinitrate during exposure to low LET gamma photons are reported. Among cellulosic films, pure viscose-regenerated clear cellulose film displayed the most extensive radiation damage, with the formation of CO_2 and carbonyl groups. The material may have promise as a particle track recorder. Gaseous products of γ radiolysis of bulk cellulosics were identified as a function of ester groups, oxygen overpressure, presence of scavenger compound, and other parameters. A decomposition mechanism is proposed involving dehydrogenation of hydroxyl groups in cellulose and deacetylation in cellulose acetates. Some additional experiments that may help to identify processes occurring in actual latent track formation are suggested. Possible methods of registration of alpha particle tracks with polytetrafluoroethylene were studied. Schemes considered included chemical etching, decoration by crystallization, etching by vacuum volatilization, decoration by graft polymerization, and decoration by bubble formation. Only the first two schemes were attempted. A search for a suitable etchant for enlarging the tracks was unsuccessful. The lack of reproducibility obtained in attempts to decorate the tracks by crystalline growth makes this method unpromising. (auth)

37978 (UCRL-18895) HOT-ATOM CHEMISTRY OF LOW ENERGY CARBON IONS IN BENZENE. Pohlit, Helmut Martin (California Univ., Berkeley. Lawrence Radiation Lab.). June 1969. Contract W-7405-eng-48. 233p. Dep. CFSTI.

Thesis.

A 10-kV ion accelerator is described with which $^{14}C^+$ beams of 1 to 2 μA intensity and variable energies between 3 and 15,000 eV (at about 3 eV energy spread) are obtained. The chemistry of these fast $^{14}C^+$ ions with various chemical substances in which they are absorbed can be investigated. At energies above ~100 eV the hot-atom chemistry of nucleogenic carbon isotopes can be simulated with this equipment. Below 100 eV, the dependence of the product-yields on the kinetic energy can give valuable information about the mechanisms and kinetics underlying product formation. Methods, and their limitations, employable in this area of chemical experimentation are discussed. The formation of products from fast ^{14}C ions and atoms in solid benzene (-196°C) were investigated. Yields of seven major products (benzene, toluene, cycloheptatriene, phenylacetylene, biphenyl, diphenylmethane, and phenylcycloheptatriene) were determined as a function of the beam energy. The yields of toluene, cycloheptatriene, and phenylacetylene strongly decreased as the beam energy decreased below 100 eV, while those of all other compounds remained constant. The energy-independent yields indicated that the corresponding products are formed from carbon atoms with less than 3 eV energy. At least 15% of the initially fast carbon ions end up in this form. The energy-dependent, i.e., decreasing, yields of toluene and cycloheptatriene, are interpreted as being due to the decreased chance of hydrogen pick-up to form the precursors CH_2, as the beam energy decreases below 100 eV. A similar conclusion is drawn for the assumed precursor C_2H_x for phenylacetylene. This indicates that pick-up of hydrogen or carbon extends up to 50 eV or more. At least 6% of the (high-energy) carbon ions react in the form of CH_2 and 3% in the form of C_2H_x. One additional major product (benzaldehyde-"U-2") contains oxygen, posing a problem that occurs uniquely in this particular accelerator technique, namely possible contamination of the chemical system during the "irradiation." "U-2"'s abnormal yield dependence on various experimental parameters (e.g., the yield increases threefold as the beam energy is lowered from 15,000 to 100 eV) is discussed in this context. A partial degradation of cycloheptatriene shows a large extent of isomerization, indicating that the reacting CH_2 carries high internal and/or kinetic energy into the product. A method is suggested that permits investigation of reactivity integrals in terms of the ratio of ^{12}C products to ^{14}C products, the fast ^{12}C atoms being a consequence of the energy loss of the fast ^{14}C ions. This method may become a useful adjunct to moderator experiments in hot-atom chemistry. (auth)

37979 THE MOLECULAR HYDROGEN YIELD IN IRRADIATED 2-PROPANOL VAPOR. Bailey, M. G.; Dixon, R. S. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). J. Phys. Chem., 73: 2451-3(July 1969). (AECL-3277).

The effect of nitric oxide and ethylene, both of which react rapidly with H atoms by addition, on the $G(H_2)$ at 125°C in γ radiolysis of 2-propanol vapor was studied. A rapid decrease in $G(H_2)$ on addition of as little as 10^{-4} electron fraction NO was followed by a slower fall-off as the NO concentration increased, indicating that NO reacts with more than one precursor of hydrogen. The effect of ethylene on $G(H_2)$ was less drastic; however, the same limiting yield of hydrogen at "infinite" additive concentrations was obtained. The average value of this unscavengable or molecular yield of $G(H_2)$ is 1.75 ± 0.4. (D.H.M.)

37980 ESR INVESTIGATIONS ON INTRAMOLECULAR ENERGY TRANSFER IN γ-IRRADIATED POLY(METHYL METHACRYLATE)-STYRENE COPOLYMERS. Wilske, J.; Heusinger, H. (Technische Hochschule, Munich). Radiochim. Acta, 11: 187-93(1969). (In German).

Radical formation under exposure to γ radiation was investigated by means of ESR-spectroscopy in these substances: polymethyl methacrylate (PMMA), polystyrene (PS), copolymers of styrene (S) with methyl methacrylate (MMA), and mixtures of the homopolymers PMMA and PS. The results show that in the investigated mixture of PMMA and PS the additivity rule is largely fulfilled; thus, there is no intermolecular energy transfer. In the copolymers, there is intramolecular energy transfer from the MMA component to the S component. Two processes are active in this transfer; one results in intramolecular energy transfer over more than 1,000 MMA units, the other over 2 to 3 MMA units. (auth)

37981 RADIOLYSIS OF SOLUTIONS OF ETHYLENE IN ETHANE. Bakale, George; Gillis, Hugh A. (Case Western Reserve Univ., Cleveland). J. Phys. Chem., 73: 2178-86(July 1969).

The radiation chemistry of pure liquid ethane at low doses and of solutions of C_2D_4 in liquid ethane was studied in order to obtain more information on the relative importance of scavenging of H atoms and of positive ions by olefins in hydrocarbon solutions. At low concentrations of product C_2H_4 or of added C_2D_4, H-atom scavenging is the predominant reaction and the effect of dose on the major products from pure ethane obeys a simple kinetic expression. At higher concentrations of added C_2D_4 an ionic reaction, which appears to be simple charge transfer, becomes increasingly significant. The concentration dependence of this latter reaction is adequately described by an expression which has been applied to several cases of electron and positive-ion scavenging. A few experiments with added oxygen lead to the conclusion that it acts as a simple radical scavenger only at very low concentrations. (auth)

37982 ELECTRON SPIN RESONANCE STUDY ON IRRADIATED COORDINATION COMPOUNDS OF PYRIDINE AND ITS DERIVATIVES. Tsuji, Kozo; Tazuke, Shigeo; Hayashi, Koichiro; Okamura, Seizo (Kyoto Univ.). J. Phys. Chem., 73: 2345-52(July 1969).

Coordination compounds of pyridine derivatives with various metal salts were irradiated. The free radicals produced by irradiation of complexes were detected by the ESR method and the effects of metal ions and anions on the formation of radicals were studied. When the central metal ions of complexes possessed high oxidation potential and vacant d orbitals, no ESR spectra were observed even after prolonged time of irradiation. The irradiated zinc complexes showed ESR spectra. Pyridine and picoline complexes with $ZnCl_2$ gave carbon radicals, whereas their complexes with $Zn(SCN)_2$ gave very asymmetric ESR spectra characteristic of sulfur radicals. The sulfur radicals increased as the sample was warmed up. On the other hand, both vinylpyridine complexes with $ZnCl_2$ and $Zn(SCN)_2$ gave ESR spectra attributed to propagating radicals. Irradiated zinc complexes were warmed up to give an ESR signal of Zn^+. Intramolecular electron transfer was assumed in these systems. (auth)

37983 RELATIONSHIP BETWEEN CRITICAL MICELLE CONCENTRATION AND RATE OF RADIOLYSIS OF AQUEOUS SODIUM LINOLEATE. Gebicki, J. M.; Allen, A. O. (Australian National Univ., Canberra. Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 73: 2443-5(July 1969).

An unusual discontinuity of the relationship between the concentration of the soap and yield of conjugated molecules was observed in a study of radiation-initiated oxidation of aqueous sodium linoleate. The initial rate of radiation formation of the conjugated derivative is linear. The rapid variation of the G_{conj} values over a narrow range of solute concentration suggests a possible connection between the critical micelle concentration (cmc) and the rate of radiolysis. (D.H.M.)

37984 REACTIONS OF CARBON DIOXIDE, SULFUR DIOXIDE, NITRIC OXIDE, AND ALKYL HALIDES WITH γ-IRRADIATED SILICA GEL. Wong, Pak Kuen; Willard, John E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1715. J. Phys. Chem., 73: 2226-30(July 1969).

The ESR spectrum of γ-irradiated silica gel was investigated before and after the addition of CO_2, SO_2, NO, and alkyl halides. None of these electron scavengers removed the "trapped electron" signal. CO_2 and SO_2 react with radiation-produced defects to produce paramagnetic species different from those (presumed to be CO_2^- and SO_2^-) formed when the gases are present on the gel during irradiation. The spectrum which results from addition of CO_2 to preirradiated gel is identical with that obtained by γ irradiation of gel containing sorbed O_2 and is attributed to O_2^-. In other experiments, it was shown that fragmentation of silica gel under vacuum produces paramagnetic centers which are removed by exposure to NO or H_2O, but not to CO_2. (auth)

37985 PERMEATION OF GASES THROUGH MODIFIED POLYMER FILMS. I. POLYETHYLENE–STYRENE GRAFT COPOLYMERS. Huang, R. Y. M.; Kanitz, P. J. F. (Univ. of Waterloo, Ont.). J. Appl. Polym. Sci., 13: 669-83(Apr. 1969).

The permeabilities of nitrogen, oxygen, and carbon dioxide through polyethylene–styrene graft copolymer films were measured by means of a gas permeability apparatus based on a modification of Barrer's high-vacuum technique. Polyethylene–styrene grafts were prepared by mutual γ-irradiation of low-density polyethylene films in styrene–methanol solution. Densities and thicknesses of the graft copolymer films were determined. It was observed that the gas permeability constants decreased with increasing grafting to minimum values at 20 to 30% styrene grafting and increased again above 30% grafting. These results are explained in terms of a decrease in the free volume of the amorphous regions of the polyethylene by a "filling in" effect of the grafted polystyrene chains. Above 30% grafting, disruption of the crystallites may occur resulting in increased gas permeation. Activation energies for gas permeation through polyethylene-styrene graft copolymer films were calculated and found to decrease with increasing per cent styrene grafting. For nitrogen permeation, the activation energy decreased from 11.7 kcal/mole for unirradiated polyethylene to 9.5 kcal/mole for a 50.5% graft. Corresponding values for oxygen and carbon dioxide were 10.2 to 8.2 kcal/mole for a 48.7% graft and 8.4 to 6.5 kcal/mole for a 50.5% graft. (auth)

37986 RADIATION CHEMISTRY OF AQUEOUS FROZEN SOLUTIONS. Schulte-Frohlinde, D.; Vacek, K. (Kernforschungszentrum, Karlsruhe, Ger.). Curr. Top. Radiat. Res., 5: 39-74(1969).

Investigations of radiation effects in frozen solutions make it possible to detect and study the properties of some unstable intermediates. The two main physical methods used are ESR and optical spectroscopy. Kinetics of reactions of mobile and trapped intermediates are discussed. Ice irradiated at various low temperatures and analyzed at room temperature yielded H_2 and H_2O_2 at relatively low G values. Trapped electrons, H atoms, and OH radicals are unstable intermediates. Isotope effects and dose effects are discussed. (M.C.G.)

37987 CHANGE OF THE SURFACE OF NEEDLE-SHAPED AND MASSIVE ALKALI HALIDE CRYSTALS UNDER THE INFLUENCE OF X RADIATION. Gol'denberg, S. U.; Kuchina, G. N. (Tomsk Structural Engineering Inst., USSR. Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 3, 133-4(1969). (In Russian).

Specimens of KCl and NaCl, consisting of needles grown by S. Amelinckx' method, and 2 × 5 × 10 mm^3 foils were exposed to x radiation under identical conditions; after exposure, their surface was examined by a metallographic microscope. The results revealed that the radioinduced changes depend on the chemical nature of the material: on NaCl rosette and tree-shaped figures were formed while on KCl separate tracks were observed. The designs on KCl appeared at a lower dose than on NaCl. An increase in dose resulted in an increase in the size and number of these radioinduced figures. The needle-shaped crystals exhibited an intensive growth of the figures; identical dendritic forms were observed on both acicular and massive NaCl crystals. Crystal growth was initiated at a lower dose on the needle-shaped specimens. These results were attributed to the stability of acicular crystals in a radiation field. (TTT)

37988 ABSENCE OF HYDROGEN ATOM PRODUCTION IN RADIOLYSIS OF SOLID HYDROCARBONS. Timm, Dietrich; Willard, John E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1715. J. Phys. Chem., 73: 2403-8(July 1969).

Radiolysis of ethane, n-hexane, 3-methylpentane, 3-methylpentane-d_{14}, or methylcyclohexane at 4°K produces the expected ESR spectra of trapped free radicals, but no evidence of trapped hydrogen atoms, although the H atom doublet is present with the CH_3 radical spectrum when CH_4 is irradiated. Radiolysis of 3-methylpentane-d_{14} at temperatures in the range from 20 to 50°K produces no trapped D atoms, although it had been shown that D atoms from the photolysis of DI in this matrix can be trapped in this temperature range. The presence of 0.3 mole % isobutene in CH_4 during irradiation at 4°K does not reduce the trapped H signal. Irradiation of 1 mole % C_2H_4 in Ar at 4°K produces little or no H atom yield compared to that from 1 mole % CH_4 in Ar. These observations lead to the conclusion that the free radicals formed by radiolysis of solid hydrocarbons are not produced by elimination of H atoms. Ion–molecule reactions are, therefore, the probable mode of formation. (auth)

37989 THE REDUCTION OF BENZENE BY HYDRATED ELECTRONS IN γ-RAY IRRADIATED ALKALINE SOLUTIONS. Studier,

Martin H.; Hart, Edwin J. (Argonne National Lab., Ill.). J. Amer. Chem. Soc., 91: 4068-72(July 16, 1969).

Hydrated electrons converted benzene into 1,4-cyclohexadiene (1,4-C_6H_8) which was further reduced to cyclohexene (C_6H_{10}) and cyclohexane (C_6H_{12}). In addition dimeric products progress from $C_{12}H_{14}$ to $C_{12}H_{22}$ as reduction proceeded. The hydrated electrons were produced by the γ-irradiation of pH 13 solutions saturated with H_2 at 1500 psi pressure. (auth)

37990 RADIOCHEMICAL ANALYSIS OF ZINC COMPOUNDS AFTER REACTOR IRRADIATION. Bogdanovic, Emilija M. (Academie de Medicine Militaire, Belgrade); Veljkovic, Slobodanka R. Radiochim. Acta, 11: 94-7(Apr. 1969). (In French).

ZnO and zinc adsorbed on an ion exchanger resin were irradiated in a reactor. The different chemical forms of the radiozinc were investigated by means of the paper chromatography. The chromatograms indicated the existence of several different chemical forms of radiozinc. The distribution of the radioactivity depended upon the nature of the target, the thermal treatment of the target, and the solvent. The solutions of radiozinc containing citrate and ammonium acetate yielded the greatest number of labeled zones. (auth)

37991 HOT ATOM CHEMISTRY OF PHOSPHORUS COMPOUNDS. III. REACTOR-IRRADIATION OF BENZENE SOLUTIONS OF PHENYLPHOSPHORUS COMPOUNDS. Kiso, Yoshiyuki; Kobayashi, Mitsue; Kitaoka, Yoshinori; Kawamoto, Keizo; Takada, Jitsuya (Kyoto Univ., Osaka). Radiochim. Acta, 11: 65-71(Apr. 1969).

The recoil reaction of ^{32}P produced by the $^{31}P(n,\gamma)^{32}P$ reaction of phosphorus compounds, such as triphenylphosphine, triphenylphosphine oxide, triphenylphosphite, diphenylphosphite, triphenylphosphate, phenylphosphinic acid, and white phosphorus, was investigated in benzene solutions of various concentrations. The ^{32}P-labeled recoil products produced in irradiated samples were analyzed by paper chromatography and paper electrophoresis. In concentrated solutions the composition and the yield of the ^{32}P-labeled recoil products are strongly affected by the chemical composition of target materials. This dependence becomes less noticeable with decreasing concentration. The curve of the yields of the recoil product plotted against the concentration shows a maximum, the position of which varies from one recoil product to another. However, for a given radioactive product it is almost independent of the choice of the target materials. The influence of benzene, as a moderator and a reagent, on the chemical behavior of ^{32}P is discussed. (auth)

37992 CHEMICAL REACTIONS IN NEUTRON IRRADIATION OF AMMONIUM SULFATE. Kunz, G.; Lieser, K. H. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 11: 72-7(Apr. 1969). (In German).

The radioactive products formed by the thermal neutron activation of $(NH_4)_2SO_4$ are found to be elementary sulfur besides sulfide, sulfite, and sulfate ions. The relative yields of these products are strongly dependent on the γ dose during the neutron irradiation. The behavior of the irradiated $(NH_4)_2SO_4$ crystals during the thermal annealing is also influenced by the γ dose of the reactor. The radioactive recoil products formed by the neutron irradiation of Na_2SO_3 again are elementary sulfur, sulfide, sulfite, and sulfate ions. No elementary sulfur, however, was observed in neutron-irradiated K_2SO_4. The only recoil products observed in this case are sulfite and sulfate ions. On the basis of the experimental data, possible reactions are discussed which may take place during the irradiation, the thermal annealing, and in the dissolution step. (auth)

37993 (n,2n) INDUCED REACTIONS IN BROMOETHANE. SCAVENGER EFFECTS WITH HYDROGEN BROMIDE. Cole, A. J.; Mia, M. D.; Shaw, P. F. D. (Nuclear Physics Lab., Oxford). Radiochim. Acta, 11: 78-86(Apr. 1969).

The distribution of radioactive products from the reaction $^{81}Br(n,2n)^{80m}Br$ in bromoethane–hydrogen bromide mixtures at −80°C was determined by using gas-chromatographic analysis. Although hydrogen bromide is expected to be almost as effective as bromine in suppressing diffusive reactions, "scavenging" was observed only for dibromo compounds, and, in particular, was absent in bromoethane. These effects were shown to be due to homogeneous reactions in which active bromoalkyl radicals acquire bromine atoms, and which are suppressed by hydrogen bromide. When allowance is made for such reactions, genuine scavenger effects are apparent and consistent with those found in bromoethane–bromine mixtures. (auth)

37994 CHEMICAL EFFECTS OF NEUTRON CAPTURE IN BROMOBENZOIC ACIDS. APPLICATION OF CLATHRATE CHROMATOGRAPHY. Sawlewicz, K.; Halpern, A. (Inst. of Nuclear Research, Warsaw). Radiochim. Acta, 11: 86-9(Apr. 1969).

The distribution of ^{82}Br among various products in neutron-irradiated m- and p-bromobenzoic acids was investigated. Clathrate-chromatography was employed as the analytical technique. (auth)

37995 STRESS RELAXATION OF NATURAL RUBBER DURING IRRADIATION. Evans, D.; Morgan, J. T.; Sheldon, R.; Stapleton, G. B. (Rutherford High Energy Lab., Chilton, Eng.). J. Polym. Sci., Part A-2, 7: 725-33(Apr. 1969).

The site of chain scission and cross-linking in vulcanized natural rubber irradiated with 4-MeV electrons has been determined by analysis of stress relaxation data. Sulfur and peroxide vulcanizates of different cross-link densities were prepared and the cross-link densities determined from stress–strain measurements. Stress relaxation was measured during irradiation using modified commercial relaxometers. The specimens were maintained in an atmosphere of nitrogen to minimize oxidative side effects. Scission is deduced to take place in the vicinity of cross-links, since the rate of continuous stress relaxation is independent of cross-link density. Scission may be associated both with cross-links initially present and with those subsequently introduced by irradiation. Cross-linking by radiation is largely a random process. However, there is a cross-linking reaction dependent to a slight extent on cross-link density as well as a small contribution from random scission reactions. G-values for the random reactions are given. (auth)

37996 ANALYSIS OF THE PRODUCTS OF RECOIL TRITIUM REACTIONS WITH HYDROCARBONS BY DUAL COLUMN RADIO GAS CHROMATOGRAPHY. Mahan, Kent I.; Weeks, Robert W. Jr.; Fee, Darrell; Garland, John K. (Univ. of Missouri, Columbia). Anal. Lett., 1: 933-9(1968).

Use of unmatched dual column switching and limited temperature programming while maintaining conditions for proportional counting in radio gas chromatography is described. Products of recoil tritium reactions with propene and cyclohexene were analyzed without sample fractionation or use of extremely long columns. Flow perturbation problems were noted and controlled. (auth)

37997 RECOVERY OF POLYMERIC PRODUCTS FROM RECOIL TRITIUM–HYDROCARBON SYSTEMS. Garland, John K. (Univ. of Missouri, Columbia). Anal. Lett., 1: 273-8(1968).

Radioactively labeled polymer found in unsaturated hydrocarbon-recoil tritium experiments is systematically recovered without interference with radio gas chromatographic analysis of the more volatile products. Sufficient polymer is recovered from the recoil tritium-liquid benzene system to cause an apparent discrepancy from the current mechanistic model. (auth)

37998 STUDY OF THE SEPARATION AND PURIFICATION OF LARGE QUANTITIES OF ^{227}Ac. Baetsle, L. H. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.); Dejonghe, P.; Demildt, R. C.; De Troyer, A.; Droissart, A.; Dumont, G. Ind. Chim. Belge, 32: Special No., (Vol. 2), 56-60(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.2).

Theoretical, experimental, and technological studies were made to perfect the production of ^{227}Ac by irradiation of ^{226}Ra in the high-flux reactor BR2. Different methods of separation and purification of the radioisotopes were tried experimentally, notably liquid–liquid extraction, precipitation, and ion exchange. Some methods of analysis are given. The results of these experiments are presented. (tr-auth)

37999 PREPARATION OF LABELED MOLECULES BY GAMMA IRRADIATION. Provoost, E. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.); Constant, R.; Lecocq, R.; Vasilescu, P. Ind. Chim. Belge, 32: Special No., (Vol. 2), 12-16(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.2).

The preparation of most labeled molecules by the classical methods of synthesis is generally long and expensive. This is why there has been envisioned the direct synthesis of certain labeled compounds by the gamma irradiation of simple and less expensive compounds. A technique for the preparation of ketones, especially of acetone-2-^{14}C is presented. A mixture of $^{14}CO_2$–CH_4 is irradiated. It appears that the speed of radiolysis of acetone is very important since this involves a large loss of the acetone formed. The possibility of the application of this method to the preparation of acetone and to other ketones is suggested if the mixture can be irradiated in a closed system which would permit the continuous recovery of the products formed. The economics of this method in relation to other radiochemical methods is discussed. (tr-auth)

38000 CHEMICAL OPERATIONS IN THE PREPARATION OF ARTIFICIAL RADIOISOTOPES. Fallais, Ch. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.); Constant, R.; Bignardi, G. Ind. Chim. Belge, 32: Special No., (Vol. 2), 9-11(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.2).

The production of artificial radioisotopes by neutron irradiation in a reactor is differentiated into two very distinct groups. First, the radioisotope produced is of a chemical nature different from the irradiated sample. It is thus without isotopic carrier, and the chemical separation has as its purpose the extraction of very small quantities by weight of an element from a relatively important target. For example, this is the case of the preparation of ^{131}I from the irradiation of Te by neutrons. Second, the radioisotope is of the same chemical nature as the irradiated target. In high neutron fluxes certain radioactive impurities can appear, impurities that moreover are not detectable by any other technique. Furthermore, for reasons of security, it is sometimes necessary to irradiate alkaline chlorides. Thus it is obligatory to separate the anions being subjected to neutron irradiation in order to obtain radioactively pure solutions; among others this is the case with ^{24}Na, ^{42}K, and ^{86}Rb. In the case of ^{45}Ca, certain radioactive impurities necessitate passage through an ion exchange column. ^{45}Ca can then be extracted by elution completely free from its impurities in some yields attaining 10^{-3} to 10^{-4}%. ^{51}Cr is obtained by irradiation of enriched ^{50}Cr and is used mostly in medicine in the form of the chromate. After dissolution of the target, the chromium is converted to the hexavalent form in an injectable isotonic solution. Some other preparations have been made the object of complete and prolonged studies. Among these are the preparation of colloidal gold and particularly the dissolution of rare gases such as ^{85}K and ^{133}Xe in isotonic solutions. The production operations are obviously followed by chemical and radiochemical controls. Rapid and easy chromatographs make possible the estimation of the radiochemical purity of certain preparations such as ^{131}I, ^{32}P, colloidal gold, human serum albumin, ^{131}I-labeled hippuran, and neohydrin marked with ^{203}Hg. Spectrometry makes it possible to obtain information on the specific activity of artificial radioisotopes produced and likewise on the control of certain production operations. (tr-auth)

38001 RADIOLYSIS OF METHANOL CONTAINING CYANOGEN IODIDE. Ogura, Hajime; Miyagawa, Tsutomu; Kondo, Masaharu (Tokyo Metropolitan Univ.). Bull. Chem. Soc. Jap., 42: 1763-5(June 1969).

Studies were made on the formation of iodine in the γ radiolysis of methanol and also on the effects of iodine cyanide on the radiolytic yields of hydrogen and formaldehyde. The reactivity of solvated electron towards iodine cyanide was also determined by using nitrous oxide as a competing solute. The results showed that iodine cyanide caused an increase in $G(I_2)$ which reached a limiting value of 3.2 at 5 mmole iodine cyanide. Also the addition of iodine cyanide caused a decrease in $G(H_2)$ and an increase in G(formaldehyde). A competition between iodine cyanide and nitrous oxide for solvated electrons in methanol was found. (P.C.H.)

38002 MODERATOR EFFECTS ON THE REACTIONS OF ^{82}Br ACTIVATED BY THE ISOMERIC TRANSITION WITH GASEOUS METHYL BROMIDE. Okamoto, Jiro; Tachikawa, Enzo (Japan Atomic Energy Inst., Tokai). Bull. Chem. Soc. Jap., 42: 1504-9(June 1969).

^{82}Br obtained via the (I.T.) process has been reacted with methyl bromide. In the gaseous phase, only $CH_2{}^{82}Br$ and $CH_2{}^{82}BrBr$ were observed as major products, whereas in the solid phase other products, such as $CH^{82}BrBr_2$ and $C_2H_5{}^{82}Br$ were also observed. Moderator experiments using He or Xe indicated that the formations of both $CH_3{}^{82}Br$ and $CH_2{}^{82}BrBr$ involve the reactions of the energetic ^{82}Br atom. This is in great contrast to the early observations of the Br_2-CH_4 system, where the ionic as well as the energetic reactions of ^{82}Br play a role in the formation of the C-^{82}Br bond. Comparison of these results with those found in the reactions of the ^{80}Br obtained via the (n,γ) process suggest that the Br atom obtained via the (n,γ) process is more electronically excited than that from the (I.T.) process. Kinetic analysis of the results gave the following relative α-values: α_{He}, 1.0; α_{Xe}, 8.8; α_{CH_3Br}, 10.3. It is suggested that, during the cooling-down process of ^{82}Br, a high inelasticity is involved in the collision of ^{82}Br, even with monatomic molecules. (auth)

38003 PULSE RADIOLYSIS STUDY OF THE FORMATION OF TRIPLET EXCITED STATES OF NAPHTHALENE, ANTHRACENE, AND BIPHENYL IN CYCLOHEXANE VAPOR. Johnson, G. R. A.; Sauer, M. C. Jr. (Argonne National Lab., Ill.). J. Chem. Phys., 51: 496-501(July 15, 1969).

The first triplet excited state of naphthalene is produced in significant amounts when cyclohexane–naphthalene mixtures are pulse irradiated in the gas phase (120°C). The yield is independent of naphthalene concentration from 0.15 mole % up to at least 3.5 mole %, and can be decreased by about 95% by SF_6, CCl_4, $C_6H_5CH_2Cl$, CH_3Br, NH_3, and H_2O. The scavengeable part of the triplet yield is attributed to neutralization of the ion $C_{10}H_8^+$ (which is formed by charge transfer from cyclohexane positive ion) by $C_{10}H_8^-$ which is itself formed by electron capture. The scavengers compete with naphthalene for positive ions or for electrons. The rate-constant ratios at 120°C for the reaction of the positive ions from cyclohexane with naphthalene and NH_3, $K(RH^+ + C_{10}H_8)/k(RH^+ + NH_3) = 0.8 \pm 0.2$, and for electron capture by naphthalene and benzyl chloride, $k(e^- + C_{10}H_8)/k(e^- + BzCl) = 3.0 \pm 0.5$, are obtained from competition studies. The triplet state of biphenyl observed in cyclohexane–biphenyl (0.2 mole %) is completely eliminated by SF_6 (1 mole %). In cyclohexane–naphthalene–anthracene mixtures, energy transfer from triplet naphthalene to anthracene is observed. (auth)

38004 WOOD–PLASTIC COMBINATION: BY MONOMER IMPREGNATION AND RADIATION POLYMERIZATION. Czvikovszky, T. (Plastics Research Inst., Budapest). At. Energy Rev., 6: No. 3, 3-99(1968).

A review of research on radioinduced polymerization of wood–plastic based on literature published up to June 1967, is presented. Various aspects of radioinduced polymerization in wood are considered, including, the main characteristics of polymerization, inhibition, retardation, effects of temperature, dose-rate, water and solvents, the molecular weight of polymer formed in the wood, the ratio of grafting to homopolymerization, and three-dimensional copolymerization in wood. The processing and properties of various wood–plastic combinations are surveyed, with special emphasis on two-component monomer systems combined, with wood, and oligomer-monomer systems combined with wood. Economic aspects and possible uses are considered. (162 references) (J.G.B.)

38005 REACTIONS BETWEEN FISSION PRODUCT ATOMS AND METAL ACETYLACETONATES IN THE SOLID STATE. I. Meinhold, H.; Reichold, P. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Radiochim. Acta, 11: 175-81(June 1969). (In German).

Metal acetylacetonates, $Me(acac)_n$, were bombarded with recoil atoms from fission products by exposing a mixture of $Me(acac)_n$ and UO_2 to neutrons. The chemical behavior of the observed species labeled with fission products were found to be very similar to that of the catcher compound. $Co(acac)_3$ e.g., which was separated from the irradiated material by sublimation and resublimated several times, contained the following radionuclides: ^{99}Mo, ^{109}Pd, ^{103}Ru, ^{105}Rh, ^{131}I and ^{133}I. The species containing ^{103}Ru, ^{105}Rh and ^{99}Mo turned out to be $^{103}Ru(acac)_3$, $^{105}Rh(acac)_3$, and $^{99}MoO_2(acac)_2$, respectively. In opposition to the results of similar investigations in other systems a postirradiative increase of the yield was observed in case of the $Me(acac)_n$ compounds. The isothermal annealing curve for the yield of $^{103}Ru(acac)_3$ in a neutron-irradiated UO_2-$Co(acac)_3$-mixture was found to be similar to the curves of isothermal annealing by ^{60}Co-γ-recoil-atoms in the same sample. As could be shown, $^{103}Ru(acac)_3$ is also formed by heating a sample doped (by coprecipitation) with ^{103}Ru. (auth)

38006 THE INVESTIGATION OF AIRBORNE RADIOIODINE IN ADSORPTION PRODUCTION METHOD. Tseng, C. L.; Weng, P. S. (National Tsing Hua Univ., Hsinchu, Taiwan). Radioisotopes (Tokyo), 18: 265-7(July 1969).

A simple method was developed for measuring the concentration of airborne radioiodine using a portable high-volume sampler with activated charcoal cartridges. Values are given for the ^{131}I loss in the production of carrier-free ^{131}I by the adsorption method at Tsing Hua. The weekly loss of ^{131}I is about 8% or 15.76 ~ 17.26 mCi of ^{131}I are lost when one 150 g H_6TeO_6 sample is processed. (D.H.M.)

38007 A COMPARATIVE STUDY OF ESR OF THE RADIATION RESISTANCE OF SOME SULFUR AND SELENOAMINO ACIDS. Colombetti, G. (CNR, Pisa, Italy); Falcone, G. Nuovo Cim., Lett., 2: 127-30(Aug. 1, 1969).

A comparative study was made of the radiation resistance with regard to radical formation of selenoamino acids and their sulfur analogues. The ability of Se groups to act as acceptors for unpaired electrons was also investigated. Radical yields and ESR spectra of the x-irradiated DL-methionine, DL-cystine, Se-methionine, and Se-cystine are reported. At first sight, results on spectral structure seem to indicate a lack of energy transfer from the irradiated molecule on the selenium atoms, but the drastic reduction of the radical yields strongly emphasizes the importance of Se in radiation resistance. (D.H.M.)

38008 METHODS FOR PREPARING THE ^{52}Mn ISOTOPE. Dmitriev, P. P.; Konstantinov, I. O.; Krasnov, N. N. At. Energ. (USSR), 26: 467-9(May 1969). (In Russian).

Tests were carried out to prepare the $T_{\frac{1}{2}}$ = 5.7-day ^{52}Mn isotope by interaction of the proper metals with protons, deuterons, and α particles, using the 1.5-m cyclotron of the Physico-Energetic Institute. The energy was varied by inserting absorbing copper foils. The chromium specimens were prepared electrolytically; the iron and vanadium specimens consisted of bundles of 20-micron thick foils; thick specimens were also used. The activity of ^{52}Mn was determined on the basis of the area of the 1434-keV photopeak; the error in the yield and cross section measurements amounted to ±13%. The results indicated that irradiation of chromium by protons or deuterons is the most efficient method for obtaining ^{52}Mn. At the same time, the $T_{\frac{1}{2}}$ = 313-day ^{54}Mn was also obtained. The reactions examined for preparation of ^{52}Mn included ^{52}Cr(p,n); ^{52}Mn; ^{53}Cr(p,2n)^{52}Mn; ^{54}Cr(p,3n)^{52}Mn; ^{52}Cr(d, 2n)^{52}Mn; ^{53}Cr(d,3n)^{52}Mn; ^{53}Cr(α,pn)^{52}Mn; ^{51}V(α,3n)^{52}Mn; ^{54}Fe(d, α)^{52}Mn. The excitation functions of the ^{51}V(α,3n)^{52}Mn and ^{54}Fe(d, α)^{52}Mn reactions were also measured. The value found for the cross section of the letter reaction within the limits of error with the data reported by N. A. Vlasov et al., although the new data were lower. (TTT)

38009 HIGH RESOLUTION NMR OF ORGANOTIN COMPOUNDS AND ESR STUDY OF X-RAY IRRADIATED ORGANIC SINGLE CRYSTALS. Cyr, Natsuko. Vancouver, Can., Univ. of British Columbia, 1968.
Thesis.

I. Organotin compounds were investigated using high resolution proton and tin-119 nuclear magnetic resonance. The tin-119 chemical shift of about forty organotin compounds were measured by absorption mode for the first time. The tin chemical shift and tin-119-proton coupling constant in some methyltinhalides were found to be solvent and concentration dependent in electron donor solvents. This dependence was attributed to the formation of higher than four coordinated complexes with solvent molecules. Equilibrium constants of the complex formation, the tin chemical shifts, and the tin-proton coupling constants of the complexes were obtained in a few solvents. The second-order paramagnetic chemical shifts of methyltinhalides, methyltin cations, and five coordinated compounds were calculated and compared with the observed tin chemical shifts. Good qualitative agreements between calculated values and observed values confirmed that the second-order paramagnetic term in tin chemical shifts is dominant in the chemical shift changes in those compounds. II. X-irradiated single crystals of malonamide and cyanoacetamide were studied by the electron spin resonance technique. In both cases at least two types of radicals were found. One was the usual π-electron type radical the proton coupling tensor of which had been studied quite extensively in the past. Besides the proton coupling and in the case of cyanoacetamide, the coupling tensor for the cyanonitrogen was also measured and discussed. The second radical found both in x-irradiated malonamide and cyanoacetamide was a σ-electron type radical which was produced by the loss of one of the amide protons (−CONH). The proton hyperfine coupling constant was found to be almost isotropic and very large, more than 80 gauss in both compounds. The nitrogen coupling tensor for the amide nitrogen was found to be axially symmetric with the unique principal value equal to 36.6 gauss in the one (malonamide) and 25.4 gauss in the other (cyanoacetamide). The principal value in perpendicular direction was found to be very small but could not be determined conclusively. A semi-empirical molecular orbital calculation was performed on the fragment of σ-electron radical together with perturbation through configuration interaction; the large isotropic proton coupling constants were explained theoretically. (Disser. Abstr.)

38010 INVESTIGATION OF THE RADIATION-INDUCED DEGRADATION OF POLYTETRAFLUOROETHYLENE BY ELECTRON SPIN RESONANCE. Hedvig, Peter. Magy. Kem. Foly., 75: 189-95(May 1969). (In Hungarian).

The structure, stability, and transformations of free radicals were studied by electron spin resonance in polytetrafluoroethylene irradiated by x rays, gamma rays, and accelerated electrons. On the basis of the measured radical transformations, the effect of oxygen in the degradation is interpreted, and the anomalous low radiation resistance of polytetrafluoroethylene is explained. A reaction scheme for the degradation is given. (auth)

38011 PROCESS FOR THE ISOLATION OF ^{32}P FROM IRRADIATED SULFUR. (to Comision Nacional de Energia Atomica (Argentina)). French Patent 1,412,120. Filed Oct. 19, 1964.

A process for the isolation of ^{32}P from irradiated S comprises dissolving the irradiated S in rectified CS_2, contacting the solution with a Si-containing glass or ceramic, e.g., borosilicate glass, soda lime glass, or porcelain, preferably having a particle size in the range 0.3 to 1.0 mm, and then recovering ^{32}P retained by the glass or ceramic. Preferably air is passed through the material before the recovery to eliminate the solvent. The recovery of the ^{32}P may be effected by treating the material with water or a diluted mineral acid, preferably having a metal orthophosphate dissolved in it. (NPO)

38012 METHOD OF RECOVERING ^{32}P FROM IRRADIATED SULFUR. (to Montecatini Societa Generale per l'Industria Mineraria e Chimica (Italy)). French Patent 1,406,913. Filed Sept. 7, 1964.

A method of recovering ^{32}P from irradiated S comprises subjecting the irradiated S to distillation under reduced pressure, preferably 1 mm Hg at 180 to 200°C, to eliminate the S; adding a mixture of red P and S in the stoichiometric ratio 2:5 to the residue; heating the mixture at about 300°C for 2 hr to form P_2S_5 containing the ^{32}P initially present; and purifying the P_2S_5 by sublimation. In a modification a mixture of the distillation residue with red P and PCl_3 or PBr_3 is treated at the boiling point under reflux with Cl_2 or Br_2 so as to form ^{32}P-containing PCl_3 or PBr_3, which are then purified by distillation. (NPO)

38013 NUCLEAR CHEMICAL PROCESS. (to Union Stock Yard and Transit Co.). French Patent 1,411,776. Filed July 30, 1964.

The patent relates to a process for the production of anhydrous hydrazine with direct application of atomic energy. Nuclear fuel particles having dimensions not exceeding 10 μ are suspended in liquid anhydrous NH_3 under pressure in a reaction chamber in which the fission is effected. The gaseous anhydrous hydrazine formed by decomposition of part of the NH_3 is separated from the liquid. After the separated liquid NH_3 is cooled in a heat exchanger to a temperature below the temperature of decomposition of the NH_3 and after being replenished, if necessary, with nuclear fuel particles, the liquid NH_3 is recirculated through the reaction chamber. Hydrogen and nitrogen, produced by undesirable decomposition of the NH_3 or of the hydrazine are separately recombined to form NH_3, which is reintroduced to the process. (NPO)

38014 EPR STUDY OF LOW-TEMPERATURE RADIOLYSIS OF SOME ORGANIC THIOCYANATES. Barsegov, R. G.; Bichiashvili, A. D.; Nanobashvili, E. M. (Inst. of Inorganic Chemistry and Electrochemistry, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 53: 581-4(Mar. 1969). (In Russian).

The γ radiolysis of ethyl, propyl, isoamyl, hexyl, and nonyl thiocyanates at 77°K has been investigated by the EPR method. Corresponding normal alkyl radicals, $R'CH_2\dot{C}H_2$, were identified as the main products, the formation of which was accounted for by the dissociative capture of electrons. Formation of radicals due to detachment of the hydrogen atom from the hydrocarbon chain has also been observed. The G-values for these radicals were measured. (auth)

38015 SCAVENGING BY OXYGEN OF RADICALS TRAPPED IN SOME IRRADIATED ORGANIC SOLIDS. Mariage, F.; Claes, P. (Univ., Louvain, Belgium). Ann. Soc. Sci. Brux., Ser. I, 83: 255-61(July 5, 1969). (In French).

The scavenging of alkyl radicals trapped in organic solids was studied by electron paramagnetic resonance (EPR). These radicals were produced by γ radiolysis of hydrocarbons or alkyl bromides at 77°K. Reactions were observed only in the case of glasses and when oxygen was occluded in the solid before irradiation. EPR spectra of $RO_2^{\cdot}$ radicals were not observed in the case of polycrystalline samples or when oxygen was not occluded in the solid before irradiation. In some cases (3-methylpentane) scavenging was complete at 77°K; in other cases (1-bromobutane) reactions occurred at a slightly higher temperature. (auth)

38016 INTERMEDIATES IN RADIATION CHEMISTRY AT LOW TEMPERATURE. Whelan, Daniel J. (Roswell Park Memorial Inst., Buffalo). Chem. Rev., 69: 179-89(Apr. 1969).

Detailed studies of the effects of high-energy radiation on simple molecules, and application of techniques for studying fast reactions and for identifying reactive intermediates, led to increased knowledge of the overall chemical changes involved in radiation chemistry. Some features of this work that pertain to simple organic systems and to aqueous systems are reviewed (126 references) to present a framework of concepts on which current investigations are proceeding. Emphasis is placed on results obtained from radiation experiments carried out at low temperatures, as studied by absorption spectroscopy and ESR spectroscopy, and mention is also made of results obtained by pulse radiolysis. Elementary processes are outlined and a classification of reaction systems is given, based on (1) systems

with hydrogen bonding (water, methanol), (2) systems without hydrogen bonding (2-methyltetrahydrofuran, saturated hydrocarbons, olefins, alkyl halides), and (3) systems containing molecules with low-lying orbitals. While a general pattern of radiation behavior of organic molecules is emerging, unambiguous characterization of many of the intermediates postulated is required as well as the study of modes of excitation in the primary radiation process, in energy-transfer reactions, and in ion–molecule reactions in the gaseous phase, in solution, and in the solid state. In many instances, the reaction pathways postulated in radiation chemistry are quite speculative in attempting to explain possible or probable reactions which can lead to the observed products. (BBB)

38017 KINETICS OF FORMATION OF CARBONYL COMPOUNDS AND ALCOHOLS UNDER RADIATION-INDUCED OXIDATION OF n-HEPTANE AND n-NONANE. EFFECT OF TEMPERATURE AND DOSE RATE. Pospelov, V. E.; Saraeva, V. V. (Moscow State Univ.). Petrol. Chem. (USSR) (Engl. Transl.), 8: No. 1, 17-22(1968).

The effects of temperature and dose rate on the formation of carbonyl compounds and alcohols by radioinduced oxidation of n-heptane and n-nonane were studied. Between the extremes of temperature examined, from –78 to +140°C, 3 ranges of temperature were observed, each being characterized by a certain activation energy and dependence of yield on dose rate. These temperature ranges were designated: I–true radiation, II–radiation thermal, and III–thermal radiation. It was found that dose rate influenced the kinetics of formation of carbonyl compounds. A reduction in dose rate from 7.5×10^{15} to 7.5×10^{13} eV/ml sec increased the yields of carbonyl compounds in the radiation thermal and thermal radiation ranges. It was also established that dose rate did not affect alcohol formation. Mechanisms of the formation of carbonyl compounds and hydroperoxides in radioinduced oxidation of n-heptane and n-nonane were considered to be of a general type. (BBB)

38018 REMARKS ON THE PROCESS OF CARRIER GENERATION IN ELECTRON-BOMBARDED CRYSTALLINE ANTHRACENE. Schott, M. (Ecole Normale Superieure, Paris). Mol. Cryst., 5: 229-43(1969).

Mechanisms of carrier generation in molecular crystals excited by photon (x) or electron irradiation are considered. If an electron is thermalized at a distance r_0 from its parent hole, the probability that this pair escapes recombination is proportional to exp $(-r_c/r_0)$ where $r_c = e^2/\epsilon\epsilon_0 kT$. In anthracene, where ϵ varies from 3 to 4.2 depending on the crystallographic direction, r_c is between 140 and 200 Å at 300°K. It is proposed that r_0 is small enough to account for the small yield observed in anthracene under x-ray excitation, ionizing through the electrons generated by x rays. Conclusions drawn from the present experiments on electron-bombarded anthracene, concerning this problem, are presented. Secondary emission results showed that the energy needed to create an electron-hole pair by electron bombardment of anthracene crystals is less than 75 eV, and that the thermalization distance of a secondary is such that initial recombination cannot account for the low yield of one pair per 400 eV obtained earlier. It is suggested that columnar recombination accounts for at least part of the difference. Results of characteristic losses of 41-keV electrons in anthracene are reported. The dominant loss, in the range 14 to 25 eV, is a solid state effect, tentatively assigned to collective oscillations of the π electrons. The free path for excitation of these oscillations by low-energy electrons should be very short and electron-hole pair creation would proceed largely through ionization of these plasmons. The small value of the pair-creation energy suggests that radiative recombination inside a column could play a large role in fast scintillation processes in anthracene. The fluorescence of anthracene under x-ray irradiation also gives a pair creation energy of about 27 eV. (BBB)

38019 RADIOISOTOPE WITH FANTASTIC PRACTICAL APPLICATIONS. Seaborg, Glenn T. S. Afr. Mining Eng. J., 79: 1103-8(Nov. 8, 1968).

The great advantage that arises from the use of ^{252}Cf as a source of fission neutrons is its compactness and portability in comparison to a reactor or an accelerator. A portable and compact neutron source, containing perhaps 5 mg Cf, would be desirable rather than having to rely on central reactor or accelerator sites for radiography. Possible uses of ^{252}Cf, which are already developed or are yet in the developmental stages are: hospital uses for diagnostic tests such as the determination of Na distribution in cases of suspected cystic fibrosis or the determination of protein-bound I; prospecting for Au, Ag, U, and many other elements by on-the-spot analyses using the neutron activation analysis technique; use in research and teaching, as a practical source of fission neutrons with intensities great enough for use in physics, engineering, and radiation biology; use for production of useful quantities of other radioisotopes, some of which decay too rapidly to permit them to be distributed commercially. One promising industrial application of ^{252}Cf is the continuous analysis of sulfur in coal, of importance in controlling air pollution. The success of the Savannah River Plant in operating a reactor there at thermal-neutron fluxes in excess of 10^{15} neutrons/cm^2 sec makes it possible to visualize gram quantities of ^{252}Cf there in 5 yr. The production rate could be stepped up by a factor of 10 to 100 by converting one or more of the Savannah River reactors to the resonance mode. (BBB)

Radiochemistry

Refer also to abstracts 38199, 38567, 38603, and 38604.

38020 CHEMICAL BEHAVIOR ENERGY-RICH COBALT IONS IN CIS AND TRANS ISOMERIC COMPLEXES. Wolf, G. K.; Fritsch, T. (Univ., Heidelberg). Radiochim. Acta, 11: 194-6(June 1969). (In German).

Chemical reactions associated with nuclear processes may be largely simulated by implantation of energetic ions into appropriate compounds. By means of an electromagnetic isotope separator Co^+ ions labelled with ^{57}Co were accelerated to 20 to 60 keV and implanted into cis- and trans-$[Co(en)_2Cl_2]NO_3$ targets (where en = ethylenediamine). The concentration of the labeled isomers and of isolated Co ions was studied as a function of energy and dose of the Co^+ beam. It was found that the formation of the labeled isomer corresponding to the configuration of the target compound decreases with increasing energy transfer. Furthermore, it was observed that the counter isomer is formed at a very low percentage in case of the trans-$[Co(en)_2Cl_2]NO_3$ as target, whereas in case of the corresponding cis-complex as target the yield of the counter isomer is considerably higher and is proportional to the energy transfer. The distribution of the labeled species and its dependence on the dose and energy of the Co^+ ion beam may be interpreted in terms of lattice defects and different stability of the isomers against radiative lattice destruction. The observations are not compatible with the "hot zone" model. (auth)

38021 MICROANALYTICAL METHODS FOR THE MEASUREMENT IN THE GASEOUS PHASE OF THE RADIOACTIVITY OF ORGANIC COMPOUNDS LABELLED WITH SOFT β EMITTERS. Mlinko, Sandor. Magy. Kem. Foly., 75: 201-5(May 1969). (In Hungarian).

An atmospheric method for isotopic analysis was developed with organic compounds labeled with ^{14}C, tritium, and ^{35}S, in which activity measurements could be carried out in the gas phase without vacuum installations on the basis of organic elemental analysis. By this method the activity of organic compounds labeled with soft β emitters can be measured using simple apparatus. (tr-auth)

Separation Processes

Refer also to abstracts 37873, 37882, 37957, 37959, 37971, 37976, 37998, 38114, 38149, 38182, 38224–38226, 38232, 38364, 38419, 38932, 38933, 38946, and 40165.

38022 (BNWL–1083) INTERIM STATUS REPORT ON THE WASTE SOLIDIFICATION DEMONSTRATION PROGRAM. Blasewitz, A. G.; Mendel, J. E.; Schneider, K. J.; Thompson, R. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 90p. (CONF-690618-1). Dep. CFSTI.

From Radioactive Waste Management Conference, Richland, Wash.

The conversion of high-level liquid waste from the reprocessing of nuclear fuel to a safer solid form is discussed. Engineering-scale radioactive demonstrations are being conducted with three alternative solidification systems: phosphate glass, spray solidification, and pot calcination. Approximately 60% of the radioactive demonstrations have been completed and have shown that the processes are feasible and essentially ready for commercial application. The behavior of the solidified waste products and evaluation of the safety and economic aspects of this behavior as related to the management of high level wastes are being determined. The radioactive demonstrations will be completed in late 1970. Although a few of the containers of solidified waste will be monitored for approximately five years to observe possible long term

effects, the majority of the product evaluation data will be available within two years. Overall technical, safety, and economic evaluations for industrial applications will be completed in 1972. (G.M.C.)

38023 (CONF-690801) SYMPOSIUM ON REPROCESSING OF NUCLEAR FUELS. Containing Papers Presented August 25, 26, 27, 1969 at Iowa State University, Ames, Iowa. Nuclear Metallurgy, Volume 15. Chiotti, P. (ed.) (Division of Technical Information (AEC), Washington, D. C.). 763p. Dep. CFSTI.

Thirty-six papers and abstracts of three additional papers presented at the conference are included. An abstract was prepared for each of the 36 papers. (M.C.G.)

For abstracts of individual papers see: 37957–37959, 38041–38063, 38932, 38933, 38946, 38976–38978, and 38997–39000.

38024 (DOCKET-50268-2) MIDWEST FUEL RECOVERY PLANT. Design and Analysis, Suppl. 1. (General Electric Co., San Jose, Calif. Nuclear Energy Div.). June 19, 1969. 162p. Dep. CFSTI.

A request for authorization of construction of the Midwest Fuel Recovery Plant (MFRP) is recorded. Information on the response of MFRP structures and equipment to seismic and wind forces is given in support of this request. The analytical program to assess earthquake and tornado damages to the MFRP Main Process Building (confinement envelope) structures, Main Process Building supported equipment, underground structures, and the plant effluent stack is described. (M.C.G.)

38025 (IN-1298) LEACHABILITY OF ZIRCONIA CALCINE PRODUCED IN THE IDAHO WASTE CALCINING FACILITY. Wilding, M. W.; Rhodes, D. W. (Idaho Nuclear Corp., Idaho Falls). June 1969. Contract AT(10-1)-1230. 11p. Dep. CFSTI.

The leachability of calcine from the fluidized bed calcination of highly radioactive zirconium-type liquid waste was measured. In 2000 hours of continuous leaching, approximately 60% of the ^{137}Cs and 40% of the ^{90}Sr were removed by leaching with distilled water at 25°C. Less than 1% of the ^{144}Ce, ^{238}Pu, and ^{106}Ru was leached under similar conditions. Less than 1% of the aluminum and zirconium, 3% of the calcium, and about 50% of the residual nitrate were dissolved by the distilled water in the leaching experiments. (auth)

38026 (KFK-797) THE EXTRACTION BEHAVIOR OF NEPTUNIUM DURING THE REPROCESSING OF IRRADIATED FUEL BY THE PUREX PROCESS. Baehr, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Nov. 1968. 45p. (In German). Dep.

The behavior of Np during fuel reprocessing was investigated in static experiments. During the dissolution of uranium oxide and uranium metal in nitric acid, Np exhibits pentavalence. At the end of the dissolution process, boiling the solutions converts Np to the hexavalent oxidation state. The stability of Np(VI) was investigated in uranyl nitrate–nitric acid solutions. Light was found to reduce the Np. The reduction was chiefly a photochemical reaction and was increased by the presence of uranium and the extraction agent. Extraction experiments were carried out with TBP. (M.C.G.)

38027 (NYO-2269-13) STUDIES IN SOLUTION AND NUCLEAR CHEMISTRY. Progress Report, October 1, 1968–September 30, 1969. Marinsky, Jacob A. (State Univ. of New York, Buffalo. Dept. of Chemistry). July 1, 1969. Contract AT(30-1)-2269. 266p. Dep. CFSTI.

Research is reported on: the ion-exchange phenomenon; the solution chemistry of the alkali metals, the alkaline earths, and the transition elements in the presence of linear and cross-linked polyelectrolytes; and, theoretical development of polyelectrolyte models for the knowledgeable interpretation of experimental results. Various ion forms of Dowex-50 resin, its polyelectrolyte analog, polystyrene sulfonic acid, polymethacrylic acid, poly-L-glutamic acid, and poly-L-aspartic acid were used to facilitate these objectives. In addition, the investigation of solvent selectivity as well as ion-exchange selectivity of Linde-A zeolite has been further extended in connection with the first objective listed. Ion-exchange, polarographic, and potentiometric techniques continue to be employed to accomplish the goals of this program. Spectral, osmotic, calorimetric, and Moessbauer studies further enhance a knowledgeable approach to these objectives. One important result of these studies during the period of this progress report has been the development of computational methods for the quantitative evaluation of stability constants of complex species in macromolecular systems. In addition, it has become possible to estimate the charge density at the surface of the polyion in the presence of complexed macromolecular species as a consequence of the mathematical treatment. Special insight with regard to their configurational properties can thus be deduced from these results as well. Results of the determination of the independent fission yields of technetium 101, 104, and 105 isotopes, obtained in the thermal fission of ^{235}U, are reported. (J.G.B.)

38028 (ORNL-3984) SHEAR-LEACH PROCESS: SEMICONTINUOUS AND BATCH LEACHING OF SHEARED, UNIRRADIATED STAINLESS-STEEL-CLAD AND ZIRCALOY-2-CLAD UO_2 AND UO_2–ThO_2. Finney, B. C.; Hannaford, B. A.; West, G. A.; Watson, C. D. (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 68p. Dep. CFSTI.

The Shear–Leach Process, basically a mechanical head-end process for recovery of fissile and fertile fuel values from discharged power reactor fuel elements, was developed as an alternative to exclusively aqueous methods such as the Darex, Zirflex, and Sulfex Processes. These aqueous processes involve dissolution of both the core and the cladding by use of strong acids such as aqua-regia, hydrofluoric acid, and sulfuric acid; therefore, exotic construction materials excelling the stainless steels are required to minimize corrosion of process and storage equipment. In the Shear–Leach Process, the fuel rods are ruptured by shearing, thus exposing the core material and permitting its preferential leaching with nitric acid; therefore, stainless steel can be used as the material of construction for piping and processing vessels. Since the cladding is not appreciably dissolved during the leaching procedure, it can be stored as a solid radioactive waste at approximately 5%, or less, of the cost of storing its liquid counterpart that results from the Darex or Sulfex Processes. A thorough study was made of the semicontinuous leaching of unirradiated stainless-steel-clad UO_2 and of the batch leaching of unirradiated stainless steel- and Zircaloy-2-clad UO_2 and UO_2–ThO_2. To demonstrate semicontinuous leaching, an inclined, rotary, enclosed-spiral leacher was constructed and successfully operated as a combination leacher and washing vessel. Essentially complete semicontinuous leaching of UO_2 was accomplished, using 6 to 8 M HNO_3 as the dissolvent, in tests involving hourly additions of sheared fuel [~24 g-moles (~6.6 kg) of UO_2 and 2.2 kg of stainless steel] over a 4-hr period. Two liquid-circulating batch leachers (10- and 90-liter liquid capacities) were constructed and operated to investigate the following parameters: sheared length; number of dissolvent additions; air sparging; fuel basket design (perforation size, shape, and free area); liquid circulation rate; and terminal thorium loading. The dissolution of UO_2 in 6 to 8 M HNO_3 was quite rapid; only a 1.5- to 2-hr period was required for essentially complete leaching of the UO_2 from 1.5- to 2-in. sections of 0.5-in.-OD stainless steel or Zircaloy-2 tubing. In the 10-liter leacher, air sparging (to suspend fines) resulted in a leaching time of 7 hr for 0.5-in. sections of stainless-steel-clad, pelletized UO_2–ThO_2; a period of about 12 hr was required for 1-in. sections. Without sparging, and at the same operating conditions in the 90-liter leacher, the dissolution time required for either 0.5- or 1-in. sections was about 18 to 19 hr; the resulting product was a 0.7 M thorium solution. There appeared to be no advantage in adding the dissolvent in increments. Within reasonable limits of hole sizes and free areas, the basket design was not a critical factor in batch leaching. A rapid boil-up rate enhanced dissolution; only about 9 hr was required to produce a 0.5 M solution at a 60-psig steam pressure, as compared with about 15 hr at a 20-psig steam pressure. The batch leaching of sol-gel-derived UO_2–ThO_2 is much slower than that of pelletized UO_2–ThO_2; a period of about 51 hr was required to leach the sol-gel material, as compared with 12 hr for the pelletized material. When the Zircaloy-2-clad, sol-gel-derived UO_2–ThO_2 was leached, the dissolver product had a zirconium concentration of only about 1 g per liter. (auth)

38029 (UCRL-18918) THE DESIGN OF AN IMPROVED DEVICE FOR ABSORPTION WITH CHEMICAL REACTION. Palkot, Edward J. Jr.; King, C. Judson (California Univ., Berkeley. Lawrence Radiation Lab.). June 1969. Contract W-7405-eng-48. 192p. Dep. CFSTI.

Thesis. Submitted by Edward J. Palkot, Jr.

When absorption is accompanied by chemical reaction in the liquid phase, the nature of the gas–liquid equilibrium data is often such that a high degree of gas purification may be accomplished in one or a very few equilibrium stages. Examples of such absorption systems that were considered in this study are the scrubbing of CO_2 from gas streams using hot, catalyzed potassium carbonate and the scrubbing of HCl from gas streams using water. Consideration was given to less commonly used devices that had features likely to result in high absorption rates and, consequently, high efficiency. The devices considered were the co-current packed column, open pipe contractors with co-current flow of gas and liquid in the froth and annular regimes, and the spray tower. On the basis of information dealing with these devices in the literature and models that were proposed to fill gaps in the literature, device sizes necessary to scrub gases of quantities and composi-

tions likely to be encountered in industry were calculated. Hierarchies of attractiveness of the devices for each of the systems studied were determined by assigning relevant cost variables to each contractor. It was found that some of the devices could well be attractive in reducing the costs of absorption in the processes considered. (auth)

38030 RAPID VOLATILIZATION OF ARSENIC, SELENIUM, ANTIMONY, AND TELLURIUM IN FORM OF THEIR HYDRIDES. Folger, H.; Kratz, J.-V.; Herrmann, G. (Univ., Mainz). Radiochem. Radioanal. Lett., 1: 185-90(July 1969).

Yields of 80 to 90% are achieved within one second in the volatilization of arsenic, selenium, antimony, and tellurium in form of their hydrides. A rapid separation procedure for selenium and tellurium from fission products is described. (auth)

38031 SEPARATION OF SOME METAL ANION COMPLEXES BY EXTRACTION CHROMATOGRAPHY IN THE SYSTEM ALIQUAT-336-HYDROCHLORIC ACID. Stronski, I. (Inst. of Nuclear Physics, Krakow). Radiochem. Radioanal. Lett., 1: 191-7(July 1969).

The separation of a mixture of small quantities of Cr(VI)–W(VI)–Mo(VI), (Mn, Zn, Co(II))–Fe(III), Ta(V)–Re(VII), and Th(IV)–Pa(V)–U(VI) by extraction chromatography in the system quaternary long-chain amine–HCl is reported. (auth)

38032 PRODUCTION OF ^{241}Am FROM NUCLEAR FUEL PLUTONIUM. Eberle, S. H.; Ali, S. A. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 11: 149-53(June 1969). (In German).

A method is described for the separation of americium from uranium and plutonium, the latter two elements being in excess by a factor of 10^3 to 10^4. Such a mixture of Am and U/Pu is a residue in the preparation of U/Pu fuel elements. The most important steps of the procedure are as follows: separation of the bulk of Pu by sorption to anionic exchange material, extraction of U from a HNO_3 solution still containing small amounts of Pu using a quarternary amine, extraction of Am from 0.2M HNO_3/7M $NaNO_3$ solution using a quarternary amine, reextraction with 6M HNO_3, purification by cation exchange chromatography, precipitation as oxalate, and thermal decomposition into AmO_2. Approximately 2.5 g of ^{241}Am were isolated. (auth)

38033 USE OF AMINEX FOR SEPARATION OF ACTINIDES AND LANTHANIDES. Hoehlein, G.; Voeller, H.; Weinlaender, W. (Technische Hochschule, Munich). Radiochim. Acta, 11: 172-5 (June 1969). (In German).

Judged on the basis of the structure the Aminex exchange material is supposed to be equally suitable for the separation of metal cations as for the separation of amino acids. This material is particularly interesting for the separation of actinide and lanthanide ions; very good separation properties are expected in this case because of the small particle size of the exchange material. Comparable experiments using AG 50 X 8 as exchange material showed that the resolution of the separation and thus the purity of the separated species is far better (by 3 to 4 orders of magnitude) in case of Aminex A5. (auth)

38034 GENERATOR FOR ^{137m}Ba ON THE BASIS OF IRON HEXACYANOFERRATE. Bernhard, H.; Lieser, K. H. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 11: 153-7(June 1969). (In German).

By treating steel turnings with hexacyanoferrate a material was obtained, the surface of which was coated with hexacyanoferrate of iron. This material proved to be highly selective for cesium like all the other hexacyanoferrates. The preparation was used in the form of an isotope generator to separate ^{137m}Ba from ^{137}Cs. ^{137m}Ba was eluted with 5 ml of 10^{-3}M HCl. The separation takes about 1 min. The yield of ^{137m}Ba was 40 to 80%. The decontamination factor was $>10^6$. (auth)

38035 ON THE EXTRACTION OF INORGANIC IONS. II. N-(DI-n-BUTYLPHOSPHORO) UREA, (N-DBPU) AS AN EXTRACTANT OF INORGANIC IONS FROM NITRIC ACID SOLUTIONS. Tsolis, A. K.; Belkas, E. P.; Perricos, D. C. (Democritos Nuclear Research Center, Athens). Radiochim. Acta, 11: 117-18 (Apr. 1969).

The extraction from 0.5, 2, 4, 6, 8, and 10 M nitric acid into a 0.1 M solution of N-(dibutylphosphoro)urea in chloroform was measured for 33 elements. Extraction coefficients of uranium(VI) and thorium were determined spectrophotometrically. Results are tabulated for elements with a maximum extraction value >10%, namely Sc(III), Zr(IV), Ce(IV), Hf(IV), Th(IV), Pa(V), U(VI), Np(IV), and Np(VI). (D.H.M.)

38036 ION-EXCHANGE SEPARATION OF THE DAUGHTER OF ^{231}Pa. Nakanishi, Takashi; Sakanoue, Masanobu (Kanazawa Univ., Japan). Radiochim. Acta, 11: 119(Apr. 1969).

A method is described for the separation of AcX (^{223}Ra), ^{227}Ac, AcB (^{211}Pb), RdAc (^{227}Th), AcK (^{223}Fr), and ^{231}Pa from each other and from a Fe-carrier. The oxalate form of Dowex-1 × 8 anion exchange column is used for the separation of ^{227}Th and ^{231}Pa then Dowex 50 × 8 cation exchange column is used to separate the other isotopes. (D.H.M.)

38037 TRI-ISO-OCTYLAMINE NITRATE MOLYBDENUM EXTRACTION. NATURE OF THE TYPES OBTAINED IN TOLUENE AND 1,2-DICHLOROETHANE. Kollar, R.; Plichon, V.; Saulnier, J. (CNRS, Paris). Bull. Soc. Chim. Fr., No. 6, 2193-9(June, 1969). (In French).

Triisooctylamine nitrate (R_3NHNO_3) extracts molybdenum(VI) in acid medium. The extracted species are the ion pairs ($2R_3NH^+$, $Mo_4O_{13}^{2-}$) in 1,2-dichloroethane. In toluene the extracted species is an aggregate (R_3NH^+, $HMO_2O_7^-$)n; the degree of aggregation increases with increasing molybdenum concentration until an aggregate insoluble in toluene and water is formed. The equilibrium constant for the reaction, $R_3N_s + H_w^+ + NO_{3w}^- \rightleftharpoons (R_3NHNO_3)_s$, is pK = 5.1 ± 0.1 in toluene and pK = 7.6 ± 0.1 in 1,2-dichloroethane. (auth)

38038 EXTRACTION OF STRONTIUM AND CALCIUM IONS INTO NITROBENZENE IN THE PRESENCE OF POLYIODIDES. Kyrs, M.; Michalukova, V.; Benes, J.; Kadlecova, L. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 34: 1709-19(June 1969).

The nitrobenzene extraction of calcium and strontium from aqueous solutions in the presence of polyiodides and the effects of pH and the concentrations of iodine, lithium iodide, lithium salts, and complexone were studied. Nitrobenzene was found to extract strontium better than calcium. Complexone was found to increase the separation factor. The results are in agreement with the present concepts of the virtually complete dissociation of polyiodides in both organic and aqueous phases. The value of 52.5 ± 5 found for the constant $[Li^+]_{org}[I_7^-]_{org}/[Li^+]_a[I_2]^3_{org}[I^-]_a$ for the systems containing water and nitrobenzene is in proportion to analogous constants found by other authors. (auth)

38039 SEPARATION OF AMERICIUM FROM CURIUM: DISSOCIATION CONSTANTS OF THE COMPLEXES WITH HYDROXYETHYLENEDIAMINETRIACETIC ACID. Merciny, E.; Duyckaerts, G. (Univ., Liege). Anal. Lett., 1: 23-9(1967). (In French).

The complex equilibria between hydroxyethylenediaminetriacetic acid and americium and curium were investigated employing an ion exchange resin technique. The dissociation constants of the complexes of the two metals as their trivalent ions are reported to be $10^{4.58}$ and $10^{4.54}$, respectively [μ = 0.15 (HCl + KCl)]. (auth)

38040 ISSLEDOVANIYA V OBLASTI PERERABOTKI OBLUCHENNOGO TOPLIVA. Materialy Simpoziuma Sev Karlovy-Vary, Chekhoslovakiya, 26 Fevralya–2 Marta 1968. (Studies of Reprocessing of Irradiated Fuel. Reports of the Symposium Held in Karlovy-Vary, [Czechoslovakia], February 26–March 2, 1968). Shtrba, I.; Khibner, I.; Tolpygo, B. K. (eds.). Prague, Czechoslovakian Commission of Atomic Energy, 1968. 458p. (CONF-680216).

Thirty-nine papers are included on reactor fuel reprocessing technology. The aspects of up-to-date and future improvements to the extraction technology for nuclear fuels, aqueous reprocessing of highly active waste formed during the reprocessing of spent fuel, regeneration of fuel elements in fast neutron reactors, and economic aspects of irradiated fuels are discussed. The first section of the conference covers studies of the efficiency and loading of pulse columns, extrapolation of miniature mixer-settlers, laboratory installations for fuel reprocessing, radiochemical methods, determination of fuel burnup by the ratio of ^{154}Eu to ^{155}Eu and ^{149}Nd content, separation of uranium from plutonium, extraction of Pu(IV) using TBP, phosphine oxide extraction of uranium, separation of ^{144}Ce and ^{90}Sr from waste, and determination of Zr–Nb and Ru. The nonaqueous processes, constitution diagrams of binary systems of fluorides of U, W, Mo, and Nb, reactions of niobium pentafluoride and ruthenium pentafluoride with the first and second group fluorides, preliminary halogenation in reprocessing of ceramic fuels, and gas chromatography for studying inorganic gaseous fluorides are discussed in the second section. (R.V.J.)

38041 MULTISTAGE CONTACTORS FOR LIQUID METAL-SALT EXTRACTION. Pierce, R. D.; Miller, W. E.; Knighton, J. B.; Bernstein, G. J. (Argonne National Lab., Ill.). Nucl. Met., Met. Soc. AIME, 15: 511-33(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Investigations of the chemistry of plutonium, uranium, and fission products in liquid metal–molten salt systems show that good recovery of purified plutonium is possible by liquid metal–molten salt extraction. The application of a semicontinuous mixer-settler for such extractions is under development. The flowsheet involves selective extraction of rare earths from a Mg–Cu–Pu–fission product alloy into a series of salts at 650°C, selective extraction of plutonium into another salt away from the nobler elements and uranium, and re-extraction and concentration of the purified plutonium in another alloy. The design specification is recovery of 99.8% of the plutonium with a decontamination factor of 10^6. During a run, some of the fluid phases flow continuously between stages, and the feed alloy is recirculated through the extractor several times. Other phases are only moved batchwise between runs. The resultant flow pattern makes application of conventional designs unattractive or impossible. The design selected consists of a modular assembly of mixer and settler chambers. A simple agitator-pump moves the fluids out of each mixing chamber to a settling chamber. The separated phases flow to adjacent mixing chambers through overflow spouts. Pumping and mixing performance was investigated for various designs. A reference design was selected, and extraction runs are ready to begin. (auth)

38042 CALCULATIONS ON THE SEPARATION PROPERTIES OF THORIUM–URANIUM FUELS BY CHLORIDE VOLATILIZATION. Fischer, E.; Laser, M.; Merz, E. (Kernforschungsanlage, Juelich, Ger.). Nucl. Met., Met. Soc. AIME, 15: 645-58(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

The composition of the gas phase resulting from a high-temperature chlorination of uranium–thorium fuels was computed for different process conditions. From these values the theoretical uranium and protactinium losses caused by a codeposition of thorium and uranium or protactinium chlorides, respectively, were calculated. The results showed that tolerable uranium losses can be achieved, if the partial pressure of uranium is very low or the deposited thorium chloride is purified by a sublimation procedure. (auth)

38043 THE REDUCTIVE EXTRACTION OF RARE EARTHS FROM MOLTEN LiF–BeF_2–ThF_4 MIXTURES INTO BISMUTH. Shaffer, J. H.; Moulton, D. M.; Grimes, W. R. (Oak Ridge National Lab., Tenn.). Nucl. Met., Met. Soc. AIME, 15: 375-84 (1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Chemical and engineering development studies of fuel reprocessing schemes for the Molten Salt Breeder Reactor Program at the Oak Ridge National Laboratory are based on the extraction of ^{233}Pa, fissionable uranium, and certain fission product species from the fluoride fuel mixture on reduction into bismuth. As a part of this experimental program, the reductive extraction of rare earths, the major soluble poison fraction in an MSBR, from selected salt mixtures in the LiF–BeF_2–ThF_4 ternary system into bismuth was investigated. The distributions of cerium, neodymium, samarium, lithium, and thorium between the two liquid phases were calculated as reaction equilibrium constants, distribution coefficients, and separation factors and were related to variations in salt composition. The magnitudes of these values establish the chemical feasibility of the extraction method for rare earth removal from MSBR fuels by multistage processing techniques. (auth)

38044 MOLTEN SALT EXTRACTION OF AMERICIUM FROM PLUTONIUM METAL. Long, J. L.; Perry, C. C. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Nucl. Met., Met. Soc. AIME, 15: 385-402(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

The removal of americium from molten plutonium metal with molten salt mixtures was investigated. A process was developed and put into production operation. Approximately 90% of the americium is removed from plutonium metal initially containing in excess of 1000 ppM of americium with two extractions, using equal weights of metal and NaCl–KCl–2.5 w/o $MgCl_2$. The average cost of the production molten salt extraction step was 3.1 man-hours per kilogram of product metal. (auth)

38045 COMPATIBILITY AND PROCESSING PROBLEMS IN THE USE OF MOLTEN URANIUM CHLORIDE–ALKALI CHLORIDE MIXTURES AS REACTOR FUELS. Harder, B. R.; Long, G.; Stanaway, W. P. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Met., Met. Soc. AIME, 15: 405-32(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

In a program designed to explore the chemical feasibility of using molten chloride mixtures as fuels for a fast reactor, experiments were carried out on a molten mixture of NaCl and UCl_3 containing UCl_4, which would arise as a result of valency imbalance in the process of fission. Available thermodynamic data suggest that over a readily controllable range of UCl_4 concentrations the melt should be compatible with potential structural metals and be stable towards disproportionation of the trichloride. The measured stability of UCl_4 and preliminary corrosion tests show that in the melt UCl_4 is less corrosive than predicted. The solubility of the oxide was measured over a range of temperature and UCl_4 concentrations. The minimum solubility recorded is sufficiently high to avoid problems of oxide precipitation. Uranium dioxide was shown to be the stable phase in contact with the melt under the conditions of interest. (auth)

38046 PREPARATION AND PROCESSING OF MSRE FUEL. Chandler, J. M.; Lindauer, R. B. (Oak Ridge National Lab., Tenn.). Nucl. Met., Met. Soc. AIME, 15: 97-120(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

The Molten Salt Reactor Experiment (MSRE) was refueled with an enriching salt concentrate, ^7LiF–$^{233}UF_4$ (73–27 mole %), which was prepared in a shielded cell in the Thorium–Uranium Recycle Facility at ORNL. The preparation process involved reducing $^{233}UO_2$ (^{232}U content, 222 ppM) to $^{233}UO_2$ by treatment with hydrogen, converting the $^{233}UO_2$ to $^{233}UF_4$ by hydrofluorination, and fusing the $^{233}UF_4$ with ^7LiF. The original MSRE fuel salt, which contained 220 kilograms of ^{235}U–^{233}U, was fluorinated to volatilize the uranium as UF_6. The UF_6 was then absorbed on packed beds of NaF pellets. Essentially all of the uranium was recovered in six runs; less than 5 grams was lost to the caustic scrubber solution. To minimize corrosion, fluorination was discontinued before the uranium volatilization was complete (i.e., 130 grams of uranium was allowed to remain in the molten salt). The uranium was decontaminated from fission products by a factor of almost 10^9. Fluorine utilization varied from greater than 70% initially to 13% (average) for the final run, and averaged 39% for all six runs. Corrosion products were removed from the barren carrier salt by reduction and filtration. Corrosion rates for surfaces exposed to fluorine during fluorination averaged 0.1 mil/hour for 47 hours. (auth)

38047 EXPERIMENTS ON PYROCHEMICAL REPROCESSING OF URANIUM CARBIDE FUEL. Brand, Glenn E.; Murbach, E. Wesley (Atomics International, Canoga Park, Calif.). Nucl. Met., Met. Soc. AIME, 15: 123-39(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

A summary of experiments on pyrochemical reprocessing of uranium carbide fuel is described. Three processes were investigated; the CARBOX process, which is based on oxidation-carbothermic reduction; a nitride-carbide cycle in which UC is converted to a nitride and then reconverted to the carbide; and a fused-salt electrolysis process in which UC is anodized in a KCl–LiCl salt bath and the uranium cathode deposit is dissolved in mercury and converted to UC by reaction with propane at 350 to 600°C. Decontamination by all three processes was studied with lightly irradiated UC (nvt ~ 10^{17}). The CARBOX and nitride processes remove about 75 percent of the fission products, but plutonium losses are high. The electrolysis process removes most (98 to 99.9%) fission products except zirconium. A 100 gram scale oxidation experiment was carried out using UC irradiated to 15,000 MWd/MTU. Batches of unirradiated UC up to 10kg were processed in scale up studies using a rotary kiln. Oxidative decladding studies were carried out in an apparatus capable of decladding 3 foot lengths of stainless steel-clad fuel. Cost studies indicated a savings of about 0.2 mil/kWh over aqueous reprocessing for a 1000-MW(e) sodium-cooled power reactor using a burnup of 20,000 MWd/MTU. (auth)

38048 SIZING THE CHEMICAL REACTORS FOR FLUORIDE VOLATILITY PROCESSING OF FAST REACTOR FUEL. Spaepen, Gustaaf J. (SCK-CEN, Mol, Belg.). Nucl. Met., Met. Soc. AIME, 15: 143-58(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

The choice of the type and size of the fluorinator in fluoride volatility processing depends on many factors such as heat dissipation, criticality, capacity, and mass transfer. An outline is given of the present state of development studies at SCK-CEN, Mol, for the experimental determination of the main factors for design and operation of an industrial unit. The project is aimed at the reprocessing of the fuel of one 1000-MW(e) fast breeder reactor. (auth)

38049 PILOT PLANT EXPERIENCE OF VOLATILE FLUORIDE REPROCESSING OF PLUTONIUM. Thompson, M. A.; Marshall, R. S.; Standifer, R. L. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Nucl. Met., Met. Soc. AIME, 15: 163-76(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

A pilot plant fluoride volatility system for the recovery of plutonium from impure oxide and residues was built at the Rocky Flats plant of the Dow Chemical Company. The results obtained from this system are encouraging and indicate that plutonium recovery and purification from impure oxide is feasible. Several significant chemical and engineering problems were encountered and resolved. Optimization and scale up of the process will require further studies. (auth)

38050 LABORATORY-DEVELOPMENT OF THE FLUORIDE VOLATILITY PROCESS FOR OXIDIC NUCLEAR FUELS. Steindler, M. J.; Anastasia, L. J.; Trevorrow, L. E.; Chilenskas, A. A. (Argonne National Lab., Ill.). Nucl. Met., Met. Soc. AIME, 15: 177-210(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Selected aspects of laboratory studies on the fluoride volatility process for spent reactor fuels are reviewed. Results obtained in studies of the fluorination of simulated oxidic fuel in a 2-in.-diameter fluidized bed are outlined with emphasis on the behavior of uranium and plutonium. The described experiments include the use of BrF_5 and fluorine as well as fluorine alone as the fluorinating agent to convert product oxides to volatile fluorides. Results are summarized on the behavior of fission product ruthenium in separations steps, on the fluorination of neptunium compounds to NpF_6 and the reaction of NpF_6 with bromine and NaF, and on process studies with irradiated fuel. (auth)

38051 ENGINEERING-SCALE FLUORIDE VOLATILITY STUDIES ON PLUTONIUM-BEARING FUEL MATERIALS. Levitz, N. M.; Carls, E. L.; Grosvenor, D.; Vogel, G. J.; Knudsen, I. (Argonne National Lab., Ill.). Nucl. Met., Met. Soc. AIME, 15: 211-30(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Plutonium-bearing fuel materials were processed in an engineering-scale alpha facility as part of a program aimed at advancing the applicability of fluoride volatility methods to processing light-water-reactor fuels. A successful program of fluidized-bed fluorination and thermal-decomposition studies was carried out on nonirradiated UO_2-PuO_2 pellet materials and PuF_4 powder charges in a study of key steps of flowsheets of current interest. Overall, kilogram quantities of plutonium hexafluoride were produced, transported, and collected satisfactorily. The results of the work are expected to find application in developing recovery processes for high-plutonium materials such as fast-breeder-reactor fuels and plutonium scrap materials. (auth)

38052 THE POTENTIAL OF THE FLUORIDE VOLATILITY PROCESS FOR FAST BREEDER REACTOR FUELS. Jonke, A. A.; Levitz, N. M.; Steindler, M. J. (Argonne National Lab., Ill.). Nucl. Met., Met. Soc. AIME, 15: 231-40(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

The potential of fluoride volatility reprocessing for application to fast breeder reactor fuels is being studied. To provide the needed information, a conceptual design of a volatility reprocessing plant was prepared, together with an extensive critique of the process. The study included selection of a process flowsheet, preliminary equipment design, rough plant layout, and a discussion of the uncertainties associated with the process. Results of the study indicate that fluoride volatility processing of fast reactor fuels has significant potential advantages, but that the development task may be as great as for other potential methods of reprocessing. (auth)

38053 CHLORINATION-DISTILLATION PROCESSING OF IRRADIATED URANIUM DIOXIDE. Hirano, Kenmei (Japan Atomic Energy Research Inst., Ibaraki); Ishihara, Takehiko. Nucl. Met., Met. Soc. AIME, 15: 241-59(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Using the difference in vapor pressure between the chlorides of uranium and those of fission products, a chlorination-distillation process of irradiated uranium dioxide fuel was investigated. Uranium recovery and decontamination were poor on a single distillation. After various improvements of the process, very high decontamination was achieved by using barium chloride as a sorption-desorption medium for the vapor of uranium chlorides. The most promising process was as follows: Irradiated uranium dioxide pellets were pulverized through an oxidation-reduction cyclic process and chlorinated by the mixed gas of argon (60%) and carbon tetrachloride vapor (40%) at about 580°C. The gas containing the vapor of the chlorides of uranium and some fission products formed was passed through the barium chloride bed in the temperature range from about 500 to 100°C, and the uranium chloride vapor was sorbed on the bed. After the high vapor pressure fission product chlorides sorbed with uranium chlorides were preferentially desorbed by heating the bed to the temperatures of about 460 to 480°C in the gas stream of argon (90%) and carbon tetrachloride vapor (10%), the uranium chlorides were desorbed as the vapor of higher uranium chlorides by heating the bed to the temperatures of about 500 to 550°C in the mixed gas stream of argon (15%), chlorine (70%), and carbon tetrachloride vapor (15%). The vapor was trapped and uranium was recovered. After repeating the sorption-desorption process twice or three times, it was possible to attain decontamination factors to gamma emitters of 5.3×10^3 or 6.5×10^4, respectively, and uranium recovery of 96 or 94%, respectively, compared to the single treatment value of 1.0×10^2 and 98%. (auth)

38054 DIRECT CHLORINATION VOLATILITY PROCESSING OF NUCLEAR FUELS: LABORATORY STUDIES. Hariharan, A. V.; Sood, S. P.; Prasad, Rajendra; Sood, D. D.; Rengan, K.; Balakrishnan, P. V.; Ramaniah, M. V. (Bhabha Atomic Research Centre, Trombay, India). Nucl. Met., Met. Soc. AIME, 15: 261-77(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Direct chlorination volatility processing schemes that are applicable to the reprocessing of a variety of thorium-based and uranium-based nuclear reactor fuel systems are discussed. Laboratory investigations have centered on the application of such a nonaqueous reprocessing method for the processing of ThO_2-UO_2 and UO_2-PuO_2 type reactor fuel materials. The oxidic fuel compositions are converted to chlorides by reaction at elevated temperatures with chlorine gas saturated with carbon tetrachloride. Separation of fuel, fertile, and fission product chlorides is achieved by selective volatilization and utilizing the high volatility of higher uranium chlorides, UCl_5 and UCl_6. The use of heated refractory alumina filter beds to facilitate condensation and filtration of intermediate volatility chlorides in the separation process is described. An important aspect of the process flow sheet is the use of heated NaCl bed to selectively and quantitatively absorb volatile uranium chlorides. Such a medium permits a variety of gas-solid reactions in the secondary purification of the uranium fraction. (auth)

38055 FUSED-SALT FLUORIDE-VOLATILITY PROCESS FOR RECOVERING URANIUM FROM THORIA-BASED FUEL ELEMENTS. Bannasch, W.; Jonas, H.; Podschus, E. (Farbenfabriken Bayer AG, Leverkusen, Ger.). Nucl. Met., Met. Soc. AIME, 15: 279-94(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Laboratory studies were made on the Fused-Salt Fluoride-Volatility Process (FSFVP) applied to thorium–uranium oxide or carbide particles in a manner analogous to the application of FSFVP to metallic fuel elements. Systematic investigation of hydrofluorination and fluorination established that the most favorable composition of the fused salt was $LiF-NaF-ZrF_4$ = 25–25–50 mole %. Corrosion of the reaction vessel (Ni or Ni-rich alloys) decreased with increasing ZrF_4 in the melt. Volatilization yields ranged up to 99.8% even when ThF_4 was present as a precipitate. In view of this high yield it should be possible to apply this process to these oxide fuels provided further steps in the process do not give rise to major difficulties. (auth)

38056 EBR-II SKULL RECLAMATION PROCESS. Winsch, I. O.; Pierce, R. D.; Bernstein, G. J.; Miller, W. E.; Burris, L. Jr. (Argonne National Lab., Ill.). Nucl. Met., Met. Soc. AIME, 15: 297-324(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

A pyrochemical process was developed for recovery of enriched uranium from residual crucible skulls that result from the EBR-II melt refining process. The process involves: oxidation of the skulls to liberate them from the crucible as a free-flowing powder; addition of the powder to a halide salt and extraction of 75 to 95% of the nobler fission product elements from the oxide with liquid zinc at 800°C; reduction of the uranium oxide by contacting the salt with a Mg-17 at. % Zn alloy at 800°C; removal of 95% or more of the remaining fission products by transferring away the molten salt and the metal alloy in which the metallic uranium is insoluble; dissolution of the uranium in a Zn–29 at. % Mg alloy; and recovery of the uranium product by retorting and melting. The Skull Rec-

lamation Process was developed and tested on a pilot and a prototype plant scale in the Chemical Engineering Division of Argonne National Laboratory. However, a change in the EBR-II reactor status from an experimental to a test reactor precluded the installation of Skull Reclamation Process equipment in the EBR-II Fuel Cycle Facility. (auth)

38057 STATUS OF THE SALT TRANSPORT PROCESS FOR FAST BREEDER REACTOR FUELS. Steunenberg, R. K.; Pierce, R. D.; Johnson, I. (Argonne National Lab., Ill.). Nucl. Met., Met. Soc. AIME, 15: 325-35(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

The Salt Transport Process currently being developed at Argonne is a pyrochemical scheme for the recovery of fast breeder reactor fuels. The process objectives are to be able to accommodate short-cooled fuels and to provide plutonium and uranium recoveries of 99% with fission product decontamination factors of 10^6 or higher. Stainless steel cladding is removed from the oxide fuel by dissolution in liquid zinc. The oxides are then reduced by a Cu–Mg–Ca alloy in the presence of a $CaCl_2$–CaF_2 flux. The subsequent plutonium–uranium-fission product separations are achieved through a series of liquid metal-molten salt extraction steps. The metallic plutonium and uranium products, which are recovered by vacuum distillation of the solvent metals, are reconverted to oxide fuel by oxidation with CO_2 in a fluidized bed reactor. The basic chemistry of the process separations was investigated and the major emphasis is now on the engineering aspects. Although the development effort is oriented toward a complete process for fast breeder reactor fuels, the initial steps show promise as a head-end treatment for aqueous processing. (auth)

38058 URANIUM AND PLUTONIUM PURIFICATION BY THE SALT TRANSPORT METHOD. Knighton, J. B.; Johnson, I.; Steunenberg, R. K. (Argonne National Lab., Ill.). Nucl. Met., Met. Soc. AIME, 15: 337-62(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Uranium and plutonium may be separated from each other and from nobler metal impurities by the salt transport method in which a solute is transferred selectively from one liquid alloy (donor) to another (acceptor) by cycling a molten salt between the two alloys. Data were obtained on the solubilities of uranium and plutonium in liquid alloys of magnesium with copper, zinc, and cadmium and on their distribution behavior between these alloys and salts containing $MgCl_2$. The chemical basis for the partitioning of plutonium, uranium, and impurity elements between the salt and metal phases is discussed and the factors that enter into a salt transport separation are described. It was shown by laboratory and bench-scale engineering experiments that the transport of plutonium and uranium takes place as predicted from the solubility and distribution coefficient relationships. Although the salt transport procedure is being developed for the reprocessing of nuclear fuels, it has potential application to the separation and purification to other metals, as well as plutonium and uranium. (auth)

38059 THE REDUCTIVE EXTRACTION OF PROTACTINIUM AND URANIUM FROM MOLTEN LiF–BeF_2–ThF_4 MIXTURES INTO BISMUTH. Ross, R. G.; Grimes, W. R.; Barton, C. J.; Bamberger, C. E.; Baes, C. F. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Met., Met. Soc. AIME, 15: 363-74(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Previous studies of the reductive extraction of protactinium and uranium from molten fluoride mixtures into liquid bismuth containing thorium gave results that suggested this as a feasible method for processing MSBR fuels. Additional studies were undertaken to confirm the equilibrium quotients for the extraction reactions $Pa^{4+}_{(F)} + Th^0_{(Bi)} \rightleftharpoons Pa^0_{(Bi)} + Th^{4+}_{(F)}$; $Q^{Pa}_{Th} = D_{Pa}/D_{Th}$ and $4U^{3+}_{(F)} + 3Th^0_{(Bi)} \rightleftharpoons 4U^0_{(Bi)} + 3Th^{4+}_{(F)}$; $Q^{U}_{Th} = D^4_U/D^3_{Th}$, where $D_M = X_{M(Bi)}/X_{M(F)}$, and to determine whether these equilibrium quotients depend significantly on the concentration of Pa^0 and/or U^0 in the bismuth phase. Experiments were conducted at 625°C ± 5° in molybdenum-lined nickel containers using bismuth and single-region MSBR fuel carrier salt (LiF–BeF_2–ThF_4, 72–16–12 mole %) with up to 0.3 mole % of UF_4 and >100 ppM ^{231}Pa. Thorium, uranium, and protactinium were added incrementally in order to duplicate, as nearly as possible, the varied concentrations that would exist in an extraction column such as might be used for the process. The experiments yielded data that show a correlation of log D_{Pa} vs log D_U, which would be expected from the stoichiometry of the reactions. This seems conclusive proof that Th^{4+}, Pa^{4+}, and U^{3+} are the important species, and that there are no significant interactions of U^0 and Pa^0 under the reducing conditions of these experiments. (auth)

38060 APPLICATION OF AQUEOUS REPROCESSING TO LIQUID METAL FAST BREEDER REACTOR FUEL. Unger, W. E.; Blanco, R. E.; Irvine, A. R.; Crouse, D. J.; Watson, C. D. (Oak Ridge National Lab., Tenn.). Nucl. Met., Met. Soc. AIME, 15: 3-23(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Low-priced power, which is one of the incentives for development of the Liquid Metal Fast Breeder Reactor (LMFBR), depends in part on economic processing of spent fuel. Some form of the Purex Aqueous Solvent Extraction process is used by nearly every major fuel processing facility in existence, and it will be desirable to extend its application to include the processing of the LMFBR fuels. These fuels are inherently more difficult to process than present light-water reactor (LWR) fuels, owing to the fact that LMFBR fuels will operate at higher specific powers and for greater burnup and will contain more plutonium than the corresponding LWR fuels. The higher specific power and burnup produce heat dissipation problems during handling and transport of the spent fuel. The high plutonium content makes short cooling a significant economic incentive, and development work will be aimed at improving our technique for accommodating short-lived fission products to make short-cooled processing feasible. (auth)

38061 AQUEOUS REPROCESSING OF THORIUM-CONTAINING NUCLEAR FUEL ELEMENTS. Kaiser, G.; Merz, E.; Riedel, H. J. (Kernforschungsanlage, Juelich, Ger.). Nucl. Met., Met. Soc. AIME, 15: 25-36(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

The KFA-TBP 23/25-process is being developed for the aqueous reprocessing of thorium-containing fuel elements. In the proposed head-end, a rapid and complete dissolution of highly sintered $(Th,U)O_2$ particles is achieved by digestion in molten potassium pyrosulfate. Fertile material is isolated as potassium sulfatothorate in a concentration step and may be stored until most of the ^{228}Th has decayed. ^{233}Pa, the 27.4-day precursor of ^{233}U, will be recovered by adsorption on powdered unfired Vycor. Uranium, consisting mainly of the isotopes ^{235}U and ^{233}U, is decontaminated by a TBP solvent-extraction procedure. A suitable flowsheet for an economical reprocessing of the sulfate-containing feed solution was developed and tested in cold runs. (auth)

38062 FUEL REPROCESSING IN INDIA: TECHNOLOGY AND ECONOMICS. Sethna, H. N.; Srinivasan, N. (Bhabha Atomic Research Centre, Trombay, India). Nucl. Met., Met. Soc. AIME, 15: 39-53(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

The approach to establishment of reprocessing facilities in India is presented in the context of technological development and economic factors in a developing country. The impact of less expensive labor and construction costs and less developed transportation facilities on the size and distribution of reprocessing facilities is discussed briefly. The capital and operating costs for the Trombay demonstration plant and the estimated costs for a 500 kg per day plant under construction for BWR and CANDU type fuels are included. The plans for reprocessing fast reactor fuels are also discussed. (auth)

38063 MELT REFINING OF EBR-II FUEL. Hampson, D. C.; Fryer, R. M.; Rizzie, J. W. (Argonne National Lab., Idaho Falls, Idaho). Nucl. Met., Met. Soc. AIME, 15: 57-76(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Melt refining is the name given to the process of selective removal of fission products from highly irradiated metallic reactor fuel by a high-temperature oxidation step in which the ceramic crucible is the source of oxygen. Volatilization of fission products contributes to the overall fission-product removal. Data obtained from four years of totally remote operation with irradiated fuel have, in general, confirmed theoretical and laboratory-obtained results. The purified metal is remotely refabricated into fuel elements for reinsertion in the reactor (EBR-II). (auth)

38064 USE OF CELLULOSE PHOSPHATE FOR THE PURIFICATION OF THE CONDENSATE FROM MICROIMPURITIES OF RADIOACTIVE ELEMENTS. Bagretsov, V. F.; Chistyakov, A. D.; Petrova, E. A. At. Energ. (USSR), 26: 469-71(May 1969). (In Russian).

The decontaminated solutions in Soviet nuclear power plants are purified by evaporation; the condensate obtained usually contains small amounts, 2.0 to 20.0 mg/l of salts; the concentration of organic compounds in the condensate lies in most cases below the sensitivity threshold of the analytical methods. However, the concentration of radioactive compounds, especially that of stron-

tium, often exceeds the maximum permissible levels for open reservoirs. The solutions are subjected to further purification by ion exchange. Among the ion-exchanger materials cellulose phosphate has a high exchange capacity and good kinetic properties. Experiments were carried out by means of a 16-mm-diameter column to determine the usability of the ammonium cellulose phosphate for such purifications. The specific β activity of the original liquors and filtrates was determined, together with the radioactive strontium, cesium, and ruthenium contents and the total concentration of rare earth elements and yttrium. The factors examined included the effect of density of the charge, the height of the layer, and the rate of filtration under removal of the β emitters. The pH of the solution was found to affect strongly the filtration properties of cellulose phosphate. About 54 to 87% of the sum of β emitters could be removed from the condensate, but 98 to 99% of the ^{89}Sr and ^{90}Sr were retained when the volume of the liquid exceeded that of the sorbent by a factor of 20,000. The ion exchanger KU-2 was more effective for rare earth elements but their concentration is usually below the maximum permissible level. Therefore, it is recommended to replace the expensive KU-2 resin with cellulose phosphate. The material is not suited for use in a regenerative process. (TTT)

38065 ON THORIUM–URANIUM PRODUCTION TECHNOLOGY FROM THE EGYPTIAN MONAZITE. PART III. SEPARATION OF THORIUM BY ION-EXCHANGE RESINS. Saad El, M. K.; Sherief, Din; Almasy, A. Ind. Chim. Belge, 32: Special No., (Vol. 2), 322-5(1967).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.2).

An economic process for separating thorium from sulfuric acid solution by using an ion-exchange resin is considered. It is known that the Th^{4+} ion forms a complex compound with SO_4^{2-} ions and this can simply be illustrated as follows: $Th^{4+} + nSO_4^{2-} \rightleftharpoons Th(SO_4)_n^{4-2n}$ where n is the number of SO_4^{2-} ions supposed to be equal to 3 to 5. The stability of the formed sulfate complex compound of thorium depends on many factors, mainly the free H^+ ion concentration of the solution of, i.e., the free sulfuric acid concentration of the monazite sulfate solution. According to the previously described sulfate complex of thorium, it may be possible to make attempts for separating thorium from other cations by using an ion-exchange resin. Two ways have been tried: the anion and the cation-exchange resins. As the basic ion-exchange resins (for example Dowex 2) have the characteristic of adsorbing the anion complexes from solutions, it was found that uranium and a part of thorium can be adsorbed from monazite sulfate solution, by applying Dowex 2 for this separation. Different sulfuric acid concentrations have been tried, from 0.5M to 1M H_2SO_4 to find that under practical conditions, separation will not be sharp and economical. It is known that the strong acidic cation-exchange resin (for example Dowex 50) can adsorb the cations from solutions. As previously stated, Th^{4+} ions form an anion-complex in the sulfate solution, so when the sulfate solution of monazite flows through the cation exchange resin columns, the other cations are selectively and tightly adsorbed from the solution and in the mean-time thorium is not adsorbed or only very loosely adsorbed. Consequently thorium is eluted by using sulfuric acid. The optimum conditions of such process were studied and large laboratory experiments were done, now plans are being established for pilot-plant production of one ton monazite capacity per day. (auth)

38066 RECOVERY OF CESIUM FROM RADIOACTIVE WASTE BY ION EXCHANGE. Piret, J.; Beaudet, C.; Balon, G. (Societe d'Etudes de Recherches et d'Applications pour l'Industrie, Brussels). Ind. Chim. Belge, 32: Special No., (Vol. 2), 17-19(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.2).

The suitability of titanium phosphate for the selective fixation of cesium present in solutions from the reprocessing of irradiated fuels is discussed. The emphasis is especially on the elution of Cs under economically interesting conditions. A previous elution of Fe makes it possible to obtain radioactive Cs sufficiently pure. This double elution does not do any damage to the exchanger. (tr-auth)

38067 RECOVERY OF ^{137}Cs AND ^{90}Sr FROM FISSION PRODUCTS. Baetsle, L. H.; Huys, D. (Centre d'Etudes de l'Energie Nucleaire, Mol, Belg.). Ind. Chim. Belge, 32: Special No., (Vol. 2), 3-8(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.2).

The recovery process is based on the selective fixation in acid medium of the radioactive elements ^{137}Cs and ^{90}Sr on inorganic ion exchangers. Molybdenum ferrocyanide preferentially fixes Cs and permits the accumulation of Cs present in 85 to 90 volumes of a layer of a column of unit volume of this ion exchanger. The decontamination coefficients vary between 10^4 and 10^5. Polyantimonic acid selectively fixes the Sr contained in about 10 volumes of the layer; the decontamination factor is of the order of 10^4. After fixation, the ion exchanger mass is volatilized by chlorination at a temperature of about 270 to 300°C, the chlorides of Mo, Fe, and Sb being much more volatile than those of Cs and Sr. The chlorides of these radioactive elements remain in the ion exchange column besides several impurities. A pilot installation was constructed to demonstrate the process at several levels of activity of the order of 10 Ci/l. By elimination of all the manipulations of elution and reconcentration as well as by the possibility of reuse of expensive products used in the fabrication of the inorganic ion exchangers, the recommended process is more economical than any of the other methods known at present. (tr-auth)

38068 36th INTERNATIONAL CONGRESS ON INDUSTRIAL CHEMISTRY, BRUSSELS, SEPTEMBER 10–21, 1966. VOLUME II. Ind. Chim. Belge, 32: Special No., 1-809(1967). (In several languages). (CONF-660905-(Vol.2)).

Papers presented at the conference are included. Separate abstracts were prepared for 16 papers. One paper was previously abstracted for NSA (22: 7989). (M.C.G.)

For abstracts of individual papers see: 37870, 37960, 37998–38000, 38065–38067, 38194–38196, 38947, 39001, 39359, 40328, and 40502.

38069 OXYGEN ISOTOPIC COMPOSITION OF SULPHATES. PART 3. OXYGEN ISOTOPIC FRACTIONATION IN THE BISULPHATE ION–WATER SYSTEM. Mizutani, Y.; Rafter, T. A. (Inst. of Nuclear Sciences, Lower Hutt, N. Z.). N. Z. J. Sci., 12: 54-9(Mar. 1969).

The oxygen isotopic fractionation between bisulphate ion and water was measured at four temperatures in the range 110°C to 200°C. The isotopic equilibrium fractionations obtained can be represented by a linear equation: $1000 \ln \alpha_{(HSO_4^- - H_2O)} = 2.88 (10^6 T^{-2}) - 4.1$. From the $\delta^{18}O$ values of dissolved sulphate and its associated water in the Wairakei geothermal water, equilibrium temperatures were calculated. They showed good agreement with the measured temperature of the geothermal water. (auth)

38070 ION EXCHANGE AND SOLVENT EXTRACTION OF METAL COMPLEXES. Marcus, Y.; Kertes, A. S. London, Wiley, 1969. 1046p. 315s.

The subject is reviewed under the following main headings: aqueous solutions of electrolytes; nonaqueous solutions of electrolytes; complex formation in solution; ion exchangers; cation exchange of complexes; anion exchange of complexes; principles of solvent extraction; extraction by compound formation; extraction by solvation; extraction by ion pairing; synergistic extraction; and applications of distribution methods. (UK)

38071 OXYGEN ISOTOPIC COMPOSITION OF SULPHATES. PART 4. BACTERIAL FRACTIONATION OF OXYGEN ISOTOPES IN THE REDUCTION OF SULPHATE AND IN THE OXIDATION OF SULPHUR. Mizutani, Y.; Rafter, T. A. (Inst. of Nuclear Sciences, Lower Hutt, N. Z.). N. Z. J. Sci., 12: 60-8(Mar. 1969).

Experimental data on the oxygen and sulphur isotopic ratios in the bacterial reduction of sulphate showed that the remaining sulphate was enriched in oxygen-18 and sulphur-34. The ratio of the oxygen-18 enrichment to the sulphur-34 enrichment in this sulphate was found to be approximately 1:4. In bacterial sulphur oxidation, the oxygen isotopic ratio of the resulting sulphate reflected mainly the oxygen isotopic ratio of the water in which the sulphate was formed. (auth)

38072 THE CHEMICAL PROCESSING OF ALUMINUM CLAD ^{233}U OXIDE FUEL ELEMENTS. Baillie, M. G.; Cairns, R. C.; May, J. R. Mech. Chem. Eng. Trans., MC4: 113-17(May 1968).

The chemical reprocessing of one kilogram of uranium-233 to remove the thorium-228 content (approximately one milligram) is described. The process involved dissolution of fuel elements containing the uranium-233 oxide, separation and purification of the uranium-233 by liquid–liquid extraction, and reconversion to decontaminated oxide. The thorium-228 was removed successfully with 98 per cent recovery of the uranium present after dissolution. (auth)

38073 36th INTERNATIONAL CONGRESS ON INDUSTRIAL CHEMISTRY, BRUSSELS, SEPTEMBER 10–21, 1966. VOLUME I. Ind. Chim. Belge, 32: Special No., 1-808(1967). (In several languages). (CONF-660905-(Vol.1)).

Papers presented at the conference are included. Separate abstracts were prepared for 26 papers. (M.C.G.)

For abstracts of individual papers see: 37895, 37909, 37910,

38074–38082, 38149, 38193, 38934, 39033, 39034, 40285, 40324–40327, 40364, 40372, 40373, and 40528.

38074 TREATMENT OF URANIFEROUS SOLUTIONS ON ION EXCHANGE RESINS IN MOVING BEDS. Minart, P. (CEN, Cadarache, France); Pelletier, M.; Mazoyer, B.; Pottier, P. Ind. Chim. Belge, 32: Special No., (Vol. 1), 526-9(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

The pilot installation, comprised of a fixation column and an elution–washing column functioning simultaneously, treats continuously 30 cubic meters per hour of mine water containing 100 mg/l of uranium on the average. It produces chlorosulfuric eluates of 10 g/l with notable economy of reactive material in respect to the fixed bed. The resins are displaced in the bed from bottom to top in an intermittent manner. The elution results obtained in a 2-inch column, translated into the number of transfer units, were applied to the industrial column. The presence of clay in the water did not harm the chemical results but necessitated washing the fixation bed periodically by counter-current circulation from bottom to top. The attrition of the resins in the isolation is avoided as long as the flow from the resins is less than 70 l/hr. This flow can be increased by using a counter-current circulation in the valves. (tr-auth)

38075 REPROCESSING OF PLUTONIUM WASTES ON ION EXCHANGE COLUMNS. Mostin, N.; Valentini, G. Ind. Chim. Belge, 32: Special No., (Vol. 1), 724-6(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

Under the group of contracts between Belgo-Nucleaire and the C.E.N. on the one hand and Euratom on the other hand, concerning studies on the development of plutonium-containing nuclear fuels, large quantities of plutonium in various forms has to be reprocessed. Their origins, their importance, and the methods used for recovery of plutonium are reviewed. In particular, the purification and concentration of plutonium by ion exchange columns are described. The fabrication cycle for plutonium-containing elements for the reactor BR-3 (PWR) is taken as an example, and the balance sheets for the recovery cycle for plutonium are compared with the case of using different methods of preparation of the plutonium-containing wastes before their purification. (tr-auth)

38076 DEVELOPMENT OF FLUORIDE VOLATILITY METHODS FOR REPROCESSING REACTOR FUELS. Steindler, M. J.; Levitz, N. M.; Jonke, A. A. (Argonne National Lab., Ill.). Ind. Chim. Belge, 32: Special No., (Vol. 1), 730-3(1967).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

A reprocessing method for nuclear reactor fuel, based on the properties of the volatile fluorides of uranium and plutonium and carried out in fluidized beds of inert, granular alumina is reviewed. Chemical decladding of the oxide fuel is by reaction of zirconium alloys with hydrogen chloride or stainless steels with mixtures of hydrogen fluoride and oxygen. The fuel is then oxidized to U_3O_8 and is fluorinated by elemental fluorine to produce the volatile uranium and plutonium hexafluorides. Alternatively, uranium hexafluoride can be formed selectively by reaction of bromine pentafluoride while plutonium hexafluoride is formed in a separate step by reaction with fluorine. Distillation of uranium hexafluoride and thermal decomposition of plutonium hexafluoride are used to purify the products. Conversion of the hexafluorides to oxides for reuse as fuel takes place by reaction with steam and hydrogen. The status of laboratory and larger-scale experiments is briefly reviewed. (auth)

38077 A NEW METHOD FOR THE REPROCESSING OF CERAMIC FUELS: FLUORINATION BY GASEOUS CHLORINE TRIFLUORIDE. Pierini, G.; Schmets, J.; Francesconi, A. (Centre d'Etude de l'Energie Nucleaire, Mol-Donk, Belg.). Ind. Chim. Belge, 32: Special No., (Vol. 1), 752-6(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

Among the fluorinating agents used for the regeneration of ceramic fuels in the form of dioxides, chlorine trifluoride has certain special characteristics. Its volatilizes uranium preferentially; it makes possible increasing the output of the installations; the reaction is less exothermic than that with fluorine; the usable temperature range is extended; and the yield is increased. The various parameters that affect this reaction and expecially the nature of the solid, the dilution of the gases and the solids, the temperature, the linear velocity of the gas, and the charge are discussed. It is shown that ClF_3 allows a great flexibility in functioning of the installations and of high capacities. (tr-auth)

38078 PROGRESS AND PROBLEMS RELATING TO THE REPROCESSING OF CERAMICS BY VOLATILIZATION IN THE FORM OF FLUORIDES. Schmets, J.; Camozzo, G.; Heremans, R.; Pierini, G. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Ind. Chim. Belge, 32: Special No., (Vol. 1), 757-62(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

Various fluorinating agents make possible the transformation of uranium and plutonium into volatile hexafluorides and to separate them from fission products. Among these fluorine and chlorine trifluoride are of particular interest. The reaction characteristics where they enter in, the apparatus, and the flowsheets are discussed. The principal items of progress are, for the fluorine regeneration cycle, the pulverization before volatilization and, for the chlorine trifluoride process, the direct attack on the fuel and the preferential fluorination. The exothermal nature of the reactions and the high radioactivity of the starting materials necessitates the use of fluid beds to accomplish the various chemical transformations. Other important aspects of the proposed flowsheets are: the final purification, the recycling of the reactants, and the treatment of the effluents. (tr-auth)

38079 PROCESS FOR PURIFICATION OF PLUTONIUM BY EXTRACTION WITH TRIDODECYLAMINE AND PRECIPITATION FROM THE ORGANIC PHASE. Van Geel, J.; Lopez-Menchero, E.; Detilleux, E. (Eurochemic, Mol, Belg.). Ind. Chim. Belge, 32: Special No., (Vol. 1), 775-9(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

The purification of plutonium separated from irradiated fuels is accomplished, generally, either by ion exchangers or by extraction by an organic solvent, followed by a reextraction in the aqueous phase. The plutonium produced is then generally precipitated in the form of the oxalate which, after calcination, gives plutonium oxide, the most common starting point for the later operations in view of the use of plutonium. The processes have several disadvantages such as the discontinuity and the volume of effluents in the case of the resins and in the case of extraction the addition of sulfates to assure reextraction. In order to remedy these problems, Eurochemic has developed a purification process consisting of an extraction by tridodecylamine, followed by the precipitation of plutonium oxalate directly from the amine phase. This avoids the reextraction from the aqueous phase. The work carried out to accomplish this process and the required apparatus, in particular a continuous precipitator for separating the organic, aqueous, and solid phases are described. (tr-auth)

38080 THERMAL METHOD OF DECLADDING STAINLESS STEEL CANNED FUEL ELEMENTS. Novoselov, G. P.; Ageenkov, A. T. Ind. Chim. Belge, 32: Special No., (Vol. 1), 799-802 (1967).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

The thermal method for steel cladding removal from oxide fuel elements includes melting the steel in an inert medium or in a vacuum with fuel separation from steel. The content of uranium in steel separated from the fuel does not exceed 0.05%. The loss of uranium is not more than 0.006%. Studies of the interaction processes and surface phenomena in solid oxide fuel–melted steel system are reported. Advantages of the method are discussed. (M.C.G.)

38081 URANIUM–ALKALINE METAL FLUORIDE INTERACTION AND RECOVERY OF PLUTONIUM AND SOME FISSION ELEMENTS. Mirkin, I. A.; Novoselov, G. P.; Kascheev, I. N.; Dogaev, Yu. D.; Ageenkov, A. T. Ind. Chim. Belge, 32: Special No., (Vol. 1), 793-8(1967).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

The results of alkaline metals fluorides interaction with irradiated and nonirradiated uranium and uranium–plutonium alloys in a wide temperature range (700 to 1300°C) are given. The experiments were carried out in resistance and inductance furnaces. The graphite, zirconium carbide, and tantalum crucibles were used for melting. It was established that uranium interacted with alkaline metals fluorides and formed uranium trifluoride at the temperature 1250°C of uranium tetrafluoride at the temperature 900°C and alkaline metal. According to the intensity of interaction the alkaline metals fluorides form the same range as the corresponding metals do according to their volatility. Investigations show that uranium can be transferred totally into melted potassium fluorides at the temperature 800 to 1000°C while into mixture of the salts $LiF–CaF_2$ with the weight ratio 1:10 and temperature 1250°C uranium is transferred in small amounts. Experiments on plutonium extraction from plutonium–uranium

alloys into melted LiF · CaF_2 were performed both in static conditions and during stirring. The influence of initial plutonium concentration in uranium on plutonium extraction speed was also studied. It was established that by means of melted fluorides practically all plutonium can be extracted from uranium–plutonium alloys (up to its residual amount in the uranium less than 0.01 mg/g). The treatments of irradiated uranium by means of the above mentioned salts show that the fission products are extracted as follows: of Cs 99.6%; of Sr, Y by 98.2% and Ce by 98%. (auth)

38082 SOME ASPECTS OF NUCLEAR FUEL REPROCESSING BY FLUORINATION METHOD. Prusakov, V. N.; Ezhov, V. K.; Lebedev, O. G.; Popov, V. K. (Inst. of Atomic Energy, Moscow). Ind. Chim. Belge, 32: Special No., (Vol. 1), 787-92(1967).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

Experimental results on fluoride volatility method of nuclear fuel recovery are reported that include fluid bed fluorination of UO_2, purification of UF_6 by reaction and sorption techniques. Data are given on analysis of binary systems: UF_6-MoF_6, UF_6-WF_6, UF_6-NbF_5, and also on the interaction of PuF_4 and some volatile fission product fluorides with solid fluorides. (auth)

38083 ON-STREAM ANALYSIS FOR LEAD IN FLOTATION FEED PULPS AT NORTH BROKEN HILL LTD. Stewart, C. C. (North Broken Hill Ltd., Australia). Australas. Inst. Mining Met. Proc., No. 230, 73-80(June 1969).

The lead concentration of flotation feed ore slurries was determined using two gamma absorption gauges mounted directly on a 6 in. diameter flotation feed pipeline. One gauge is a conventional "density" gauge using ^{137}Cs. The other is a "lead-sensitive" gauge, which depends on the preferential absorption by lead of 225 keV gamma rays resulting from Compton backscatter of ^{137}Cs gamma rays. Gauge outputs are combined using an analog computer in which the output signal is directly proportional to the lead concentration of the pulp. The accuracy of measurement of the pulp lead concentration is ±3.6 per cent for ore slurries with lead concentrations in the range 0.07 to 0.16 g/cc and pulp densities 1.43 to 1.60 g/cc. The development of the technique and details are given of the two experiments (1964, 1966) conducted in the plant at North Broken Hill Limited. The installation of the two-gauge system in the plant during May 1968 is described. Details are given of the calibration technique used and the results obtained. (UK)

38084 SEPARATION OF MICROQUANTITIES OF TANTALUM FROM NIOBIUM BY SORPTION OF CHELATE RESINS. Savvin, S. B.; Myasoedov, B. F.; Eliseeva, O. P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 24: 1023-6(July 1969). (In Russian).

A study has been made of the sorption of niobium and tantalum by chelate resins (azo derivatives of polystyrene containing the arsono groups). The possibility of separating niobium from traces of tantalum by means of tantalum sorption on the S-1 resin from 20 N H_2SO_4 solutions is discussed. (auth)

38085 REPROCESSING OF IRRADIATED THORIUM-CONTAINING FUEL ELEMENTS. Hartwig, J.; Ulrich, K. H. (Zentralinstitut fuer Forschung und Entwicklung, Essen). Tech. Mitt. Krupp, Forschungsber., 27: 27-36(May 1969). (In German).

The high-temperature pretreatment of nuclear fuel elements containing coated particles to break up the pyrolytic carbon coatings is discussed. The pretreated fuel elements are reacted with chlorine to extract uranium. An explanation of the reaction mechanism is given, and the pilot plants are described. (auth)

38086 BASIC STUDIES ON THE SEPARATION AND RECOVERY OF ^{137}Cs FROM RADIOACTIVE WASTES USING ZEOLITE. Horioka, Masakazu (Tohoku Univ., Sendai). Nippon Genshiryoku Gakkaishi, 11: 406-16(1969). (In Japanese).

Attempts were made to find a useful procedure for the separation and recovery of ^{137}Cs with zeolite, a natural inorganic exchange mineral, from high-level radioactive liquid wastes and reprocessing effluents. A basic study was made on representative domestic samples of zeolite to establish practical procedures for their application to radioactive treatments. Tests were performed by both batch and column methods, with various types of zeolite to determine the exchange capacity as well as the decontamination efficacy of ^{137}Cs from radioactive solutions. From an examination of the ion-exchange performance of domestic clay minerals, zeolite had been found to be effective in the treatment of high level radioactive wastes. Zeolite has proved extremely useful particularly for the separation and recovery of ^{137}Cs from highly concentrated waste containing such elements as H^+, Li^+, Na^+, Ca^{2+}, Ba^{2+}, Sr^{2+}, Al^{3+}, and Fe^{3+} as well as HF. The ^{137}Cs fixed in the zeolite may be easily eluted with monovalent ions such as Na^+, K^+, and NH_4^+. The ^{137}Cs recovered by the zeolite is ready for use as the radiation source without further treatment. Ammonium chloride is considered to be an excellent eluant, and the recovery of ^{137}Cs from the eluate is extremely simple. (auth)

38087 PROCESS FOR THE INCINERATION OF IRRADIATED FLUORINE-CONTAINING ORGANIC LIQUIDS. (to Commissariat a l'Energie Atomique). French Patent 1,495,622. Filed Aug. 12, 1966.

A process for incineration of irradiated fluorine-containing organic liquids comprises mixing the liquid with a metal soap consisting of a Ca salt of a fatty acid, incinerating the mixture, preferably at a temperature in the range 700 to 1000°C, and filtering the combustion gases to retain entrained CaF_2. The metal soap must be added in a quantity at least equal to the stoichiometric quantity necessary to neutralize the HF liberated in the combustion process. Preferably twice that quantity is used. (NPO)

38088 METHOD FOR PROCESSING ALUMINUM-CONTAINING NUCLEAR FUELS. (to United States Atomic Energy Commission). French Patent 1,426,008. Filed Mar. 9, 1965.

A method for processing Al-containing spent nuclear fuel comprises dissolving the fuel in a molten salt solvent consisting of 67 mole % KF, 21 mole % ZrF_4, and 12 mole % AlF_3, until the AlF_3 content of the melt is no greater than 32 mole %. The dissolution is effected at a temperature below 600°C while anhydrous HF is passed through the melt. Then fluorine gas is passed through the melt while the temperature is maintained at about 600°C to convert the dissolved fuel values to the volatile hexafluorides. Thereafter a portion of the melt is discarded, and KF and 2KF · ZrF_4 are added to the remaining melt in order to bring the composition of the melt back to the initial composition. If the spent fuel is U, the volatile UF_6 is purified by cooling it to about 100°C and absorbing it on a bed of NaF pellets to separate it from its fission products. The temperature of the bed is raised to about 400°C to remove the UF_6 from the bed, thereby further decontaminating it from the fission products and finally recovering it in purified form. (NPO)

38089 PROCESS FOR THE REGENERATION OF IRRADIATED URANIUM-CONTAINING NUCLEAR FUEL. (to Gesellschaft fuer Kernforschung mbH). French Patent 1,487,600. Filed July 22, 1966.

Irradiated U-containing nuclear fuel is regenerated by chlorinating the irradiated fuel at a temperature preferably exceeding 700°C, subliming the mixed chlorides so as to form a deposit in a condensation tube, subjecting the mixture to a heat treatment at a temperature preferably exceeding 200°C, continuously removing the developed free Cl_2 by evacuation, and then separating the mixture of chlorides into its components or groups of components, e.g., by fractional distillation or fractional electrolysis in a molten bath. An apparatus for effecting the process is shown in detail in an accompanying drawing. (NPO)

38090 ISOLATION OF RHENIUM FROM SOLUTION BY ION EXCHANGE AND EXTRACTION. Karavaeva, S. D.; Shokanov, A. K. Tr. Khim.-Met. Inst., Akad. Nauk Kaz. SSR, 3: 92-6 (1967). (In Russian).

Rhenium is separated from solutions by passing the solution containing 0.78 to 5g of Re/l through a column (15 cm × 4 mm) of anionite (AV-17, AV-27, or Amberlite IRA-401, Cl^- form at 6 column-volumes/hr and eluting the Re with 2% thiourea solution in 0.7N HCl (3 or 4 × 5 ml) at 3 column-volumes/hr. More than 99% of the Re is eluted. The $HReO_4$ is extracted from the elute into 2 portions of TBP (each 25% of the volume of the aqueous phase) by shaking for 8 min. The extracted species contains $HReO_4$ and TBP in the ratio of 1:1. With prepared solutions (1.31 to 5g of Re/l) and industrial solutions from the production of Mo (0.78 to 1.5 g of Re/l) the % of extracted Re was 99.75 to 99.88 and 98.72 and 99.62, respectively. (Referativnyi Zh.)

38091 EXTRACTION OF MOLYBDENUM(V) WITH O,O,S-TRIPROPYL DITHIOPHOSPHATE FROM HYDROCHLORIC ACID SOLUTIONS. Busev, A. I.; Rodinova, T. V. (Moscow State Univ.). Anal. Lett., 2: 9-14(Jan. 1969). (In German).

The solvent extraction of molybdenum with O,O,S-tripropyl dithiophosphate from hydrochloric acid has been studied. The extractable species is $H_2[MoOCl_5] \cdot 2(C_3H_7O)_2P(S)SC_3H_7$ and the thiophosphate can be used to separate molybdenum from Th, Zr, Ti^{4+}, V^{5+}, Nb, Ta, Cu^{2+}, Fe^{2+}, Co^{2+}, Ni, and Mn^{2+}. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 37885, 37914, 38024, 38303, 38341, 38352, and 39920.

38092 (EUR-3741(Vol.1)) GENERAL STUDY OF RADIOACTIVITY OF THE RHINE BASIN. (European Atomic Energy Community). 1968. 211p. (In French). Dep.

A general study was made of the radioactivity of the Rhine basin in Germany, France, Luxembourg, and the Netherlands. A preliminary measurement was made of the radioactivity of the mud. Monthly studies were made of the radioactivity of the mud, earth, and suspended matter and of the fixation capacity of the total mud. A monthly measurement was made of the radioactivity and the fixation capacity of various mud fractions. The ^{226}Ra and ^{90}Sr present in the water and the different fractions of the fluvial mud were measured. A detailed description is given of the sampling and measurement methods used. The nuclear installations located in the Rhine basin are described. (J.S.R.)

38093 (USGS-474-1) PRELIMINARY LITHOLOGY OF DRILL HOLE UCe-1, CENTRAL NEVADA, SUPPLEMENTARY TEST SITE. Hedlund, D. C.; Corchary, G. S. (Geological Survey, Denver, Colo.). Nov. 1967. 4p. Dep. CFSTI.

Exploratory drill hole UCe-1 reached a total depth of 2,000 feet having penetrated 1,660 feet of granite between 340 feet and 2,000 feet. The granite is overlain by 340 feet of granitic fanglomerate and weakly indurated coarse limonitic granitic sand. Weathered friable granite extends from 340 to 380 feet. The unaltered granite is very light gray, medium-grained, hypidiomorphic granular, and is commonly well jointed. Altered rock is also light gray and the alteration (argillic) is generally joint controlled. The texture of the cored rock contrasts with the texture of the granite in adjacent outcrops, which are coarsely porphyritic. (auth)

38094 (USGS-474-3) TEMPERATURE DATA FROM EXPLORATORY BOREHOLES AT THE SUPPLEMENTAL TEST SITE, CENTRAL NEVADA: INTERIM REPORT. Munroe, Robert J.; Moses, T. H. Jr. (Geological Survey, Menlo Park, Calif.). Jan. 1969. Contract AT(29-2)-474. 15p. Dep. CFSTI.

Precise temperature measurements were made in exploratory boreholes at the Supplemental Test Site, Central Nevada. With thermal properties measurements made on the core and additional temperature measurements in progress these data will be used to estimate geothermal flux from the area. The sites and data pertinent to the state of disequilibrium at the time of measurement are tabulated. In the geothermal profiles the temperature is given in degrees centigrade and the depth in meters. (auth)

38095 (USGS-474-12) GEOLOGIC EFFECTS OF THE GREELEY EVENT, NEVADA TEST SITE. Dickey, D. D.; Jenkins, E. C.; McKeown, F. A.; Lee, W. H. (Geological Survey, Denver, Colo.). June 1967. 5p. (NTS-196). Dep. CFSTI.

The intermediate yield Greeley event, in which a nuclear device was detonated at a depth of 3,990 feet in Pahute Mesa at the Nevada Test Site, caused fracturing in rocks and spalling of rock from cliffs as far as 3.5 and 8 miles, respectively, from the detonation point. (auth)

38096 WATER PROTECTION AND ENERGY PRODUCTION. Hornef, Hermann; Wagner, Hubert. Gas- Wasserfach, 109: 1457-8(Dec. 27, 1968). (In German).

The increasing contribution of nuclear power stations to energy supplies brings problems of water protection, since many of the power stations will be built on rivers. For a nuclear station of 600 MWe, up to 40 m^3 of water may be required for cooling. Precautionary actions necessary are planning of sites with consideration for the security of the population's consumed water; consideration of present and future uses of the water supply in economic, legal, and health viewpoints; prevention or decrease of heating of water through introduction of the cooling or other waters from within the plant; and increasing the self-purification and improvement of the state of the water through artificial aeration. Solutions to these problems must be found by joint exploration of the water economy and the power economy. (BBB)

38097 THE STRONTIUM ISOTOPIC GEOCHEMISTRY OF GRANULITIC AND ECLOGITIC INCLUSIONS FROM THE BASIC PIPES AT DELEGATE, EASTERN AUSTRALIA. Compston, W.; Lovering, J. F. (Australian National Univ., Canberra). Geochim. Cosmochim. Acta, 33: 691-9(June 1969).

Comparison of $^{87}Sr/^{86}Sr$ in xenoliths and their basaltic matrix at the time of formation of the Delegate breccia pipes showed that two of four xenoliths examined have an accidental origin. The major minerals of a granulite xenolith showed variable ^{87}Sr abundances which were probably relict in part from a much older equilibrium, whereas those from an eclogite xenolith appeared to register a time equal to or not more than 10^8 years prior to the pipe age. Alkali abundances measured in the total-rock could not be accounted for by the alkali abundances measured in the major mineral phases, so that it was difficult to envisage the total-rock as chemically closed to Rb during pipe formation or for a lengthy period prior to this event. (auth) (UK)

38098 GEOCHEMISTRY OF ISOTOPES, ITS GEOLOGICAL AND MINING APPLICATIONS. Kaplan, G. (Centre de Recherches, Pau, France). Ann. Mines, 29-48(Oct. 1968). (In French).

An introduction to the geochemistry of isotopes is given. The nature of isotopes; composition of elements; factors modifying isotopic ratios (radioactive decay, temperature, diffusion, chemical isotopic exchange, biological action); the measurement of ages through the large families of elements, the small families, and those where radioactivity is induced by cosmic radiation; the usual procedures for absolute dating (K-Sr, Rb-Sr, U-Th-Pb, and others); interpretation of age measurements; chemistry of fossilized material, including temperatures and crystallization (the $^{18}O/^{16}O$ thermometer), biological activity (C, S), conditions of genesis and medium (origins of basic rocks, metallic sulfides, fluids), conditions for deposition (temperature and migration); and other topics are used to suggest future developments in the field. (BBB)

38099 WATER POLLUTION POTENTIAL OF AIR POLLUTION CONTROL DEVICES. Gartrell, F. E. (TVA, Chattanooga, Tenn.). pp 535-49 of Air Pollution. Second Edition. Vol. 3. Stern, Arthur C. (ed.). New York, Academic Press, 1968.

The interrelationships between atmospheric and stream pollution control measures are discussed. Water quality standards are evaluated. Atmospheric pollution control facilities incorporating stream pollution control features for fluorine wastes, radioactive wastes, sulfurous wastes, fly ash, dusts, and other particulate wastes, are described. (R.C.K.)

38100 NATURAL AND FALLOUT RADIOACTIVITY IN THE SAN FRANCISCO BAY AREA. Wollenberg, Harold A.; Patterson, H. Wade; Smith, Alan R.; Stephens, Lloyd D. (Univ. of California, Berkeley). Health Phys., 17: 313-21(Aug. 1969).

A compilation of gamma spectrometric data from soil samples collected at 27 fallout monitoring locations in the San Francisco Bay area revealed that natural terrestrial gamma dose rates range from 3 to 13 $\mu R/hr$ with a modal value of 5.5 $\mu R/hr$ (a 10-yr background dose of 480 mR). There was good agreement between the natural dose rates determined by radioactivity measurements made in the field with a portable counter and those derived in the laboratory by pulse-height analyses of soil samples. Analysis of the measurements made with the portable NaI counter from March 1958 through March 1968 yielded an average fallout gamma integrated dose for the 27 locations of 280 mR, assuming that all fallout was deposited evenly with respect to time. Roughly three times as much gamma-emitting fallout was deposited in the San Francisco Bay area between March 1958 and the end of 1960 as has been deposited since 1960. (auth) (UK)

38101 TRITIUM IN THE ENVIRONMENT FROM NUCLEAR POWER PLANTS. Weaver, Charles L.; Harward, Ernest D.; Peterson, Harold T. Jr. (Bureau of Radiological Health, Rockville, Md.). Public Health Rep. (U. S.), 84: 363-71(Apr. 1969).

An analysis of the effect of an expanding nuclear power industry on environmental tritium levels indicates that future tritium releases from reactors and spent-fuel processing plants may surpass the quantity of tritium remaining from nuclear weapons tests. A general information guide on tritium is presented for persons engaged in Federal, State, county, and local public health activities. The various sources and mechanisms for release of tritium and its pathway from nuclear facilities to the environment are described. Annual liquid radioactive waste discharges are shown for several operating nuclear reactors. Tritium may comprise between 50 and almost 100% of the total amount of radioactive material discharged as liquid waste. Tritium discharge concentrations, however, are usually much less than 1% of the discharge limit as specified by the Code of Federal Regulations. Tritium detection is outlined. Environmental tritium concentrations reported by the tritium sampling network for 1964 to

1966 ranged between 2×10^{-6} and 2×10^{-5} μCi/ml. Population exposure rates from continuous ingestion of this water would range from 0.33 to 3.3 mRem/yr. The maximum concentration reported would contribute less than 3% of the normal average population exposure rate of 125 mRem/yr from all natural sources of radioactivity. The results obtained from this sampling network indicated, with one exception, that waters downstream from nuclear facilities did not show any significantly higher tritium concentrations than streams which did not have operating nuclear reactors on them. Total tritium produced from nuclear power facilities in the year 2000 will be more than 10^8 Ci, ~5% of the maximum tritium activity present in 1963. At present, tritium releases from operating power reactors are only a small fraction of the discharge concentrations permitted by the Code of Federal Regulations and do not constitute a danger to health. (BBB)

38102 RADIOCARBON DATING WITH LIQUID SCINTILLATION. Dupain-Kierkx, L.; Germai, G. (Univ., Liege). Bull. Soc. Roy. Sci. Liege, 38: 50-3(1969). (In French).

The method used for radiocarbon dating of samples of wood and wood charcoal is described. The counting is carried out by liquid scintillation; the substance incorporated into the scintillating mixture is methyl borate. This substance is the final product of a series of chemical transformations: combustion of the dated sample, reduction of the carbon anhydride to methanol; esterification of the methanol to methyl borate. (tr-auth)

38103 SIGNIFICANCE OF SPONTANEOUS FISSION OF URANIUM ATOMS IMPURITIES IN MINERALS FOR METASOMATIC PROCESSES. Manecki, A. (Katedra Mineralogii i Petrografii, Krakow). Bull. Acad. Pol. Sci., Ser. Sci. Geol. Geogr., 16: 169-70(1968).

Mica and K-feldspar samples selected from the pegmatitic granites and granodiorites of the outer zone of the Tatra mountains were studied for U tracks. The micas were separated by means of heavy liquids. Muscovites were etched with 48% HF for 4 hr at room temperature. Tracks developed in all varieties of these rocks. Larger track accumulations occurred near grain boundaries, and along some cracks in the flakes of these minerals; the tracks also appeared more densely in inner zones of flakes. Megacrysts of K-feldspars were etched at room temperature for 6 to 8 sec with 48% HF. Considerable difficulty was met in distinguishing between the tracks and dislocations. The tracks were developed in the shape of shallow depressions; they did not occur in major accumulations and their number was much smaller than in muscovites separated from the same rocks. Uranium may occur in rocks as microinclusions of accessory U minerals, and as a trace element, occupying defect sites in the crystal structure of minerals, in dislocations, or in intergrain zones. When the rock is exposed to the action of metasomatizing solutions, the U tracks may be enlarged, because some active hydrothermal solutions are apt to corrode such damaged zones of the crystal structure of minerals. This ultimately leads to perforation of the minerals. This process facilitates and accelerates the metasomatic transformation of minerals such as feldspars. (BBB)

Meteorology

Refer also to abstracts 38024, 38099, 38303, 38519, and 40378.

38104 (AD-686830) FALLOUT MODEL ANALYSIS. Final Report. Seery, Carol J. (Ford Instrument, Long Island City, N. Y.). Nov. 1968. Contract N00228-67-C-2010. 170p. (FD-2428; USNRDL-TRC-68-46). CFSTI.

A comparison of the fallout radiation predictions of six fallout prediction models is presented. The comparison is presented by graphs of the downwind extent of the radiation contours predicted for four hypothetical burst conditions. The TINCAN model was developed into a fractionation fallout prediction constant wind model, and is presented. Included are the model analysis, programming details, program flow charts, and the computer program. The TINCAN model was used to obtain a sensitivity study on the effects of various parameters on predicted exposure rate values. The parameters varied were cloud height, particle settling rate function, particle frequency distribution, refractory activity mass fractions, and cloud radius. The sensitive parameters were the refractory mass fractions, particle frequency distribution, and cloud radius. (auth) (USGRDR)

38105 (CXRL-10) CONCENTRATIONS OF ^{210}Pb IN RAINWATER IN AUSTRALIA DURING THE YEARS 1964-1967. Bonyman, J.; Molina-Ramos, J. (Commonwealth X-Ray and Radium Lab., Melbourne (Australia)). 1969. 11p. Dep.

The results are given of monthly sampling of rain for ^{210}Pb at Australian stations for the period 1964 to 1967, using funnel ion-exchange fallout samplers. Radiochemical methods used, and the results of ^{90}Sr and ^{137}Cs have been reported previously. The work commenced in July 1963 at eight cities, and was extended in 1964 to a total of sixteen stations, including six milk producing localities. Data are tabulated. (Australia)

38106 REMOVAL OF AEROSOL PARTICLES AND FRACTIONAL SEPARATION OF HDO-H_2O DURING SNOWSTORMS. Rosinski, J.; Langer, G.; Bleck, R. (National Centre for Atmospheric Research, Boulder, Colo.). J. Atmos. Sci., 26: 289-301(Mar. 1969).

Differences in the deuterium content of solid precipitation collected at different times during the entire period of snowfall should indicate what environmental conditions were present during formation of those snow crystals. Experimental data collected during several snowfalls in the winters of 1966 and 1967 were examined to permit formulation of hypotheses of snow crystal and snowflake formation under natural conditions. The concentrations of both D and water-insoluble particles in snow collected in the mountains of Colorado were found to be proportional to the size of snowflakes. Large snowflakes were associated with high particle concentration and high D content. Small snow crystals appear to have originated in D- and aerosol-particle depleted air. The small snow crystals appeared at times of highest ice-forming nuclei concentration in air. The ratios of concentrations of different sized particles present in snow collected during a brief snowshower in March revealed that the predominant particles within small snow crystals are indeed those corresponding to the size range of ice nuclei. Generally, the masses of unrimed snowflakes appeared to be directly proportional to their D content and their particle concentration; this indicates the growth of ice crystals in the presence of evaporating cloud droplets. The values of the transfer coefficients of aerosol particles into the ice phase varied with particle size. The largest values were for 1.5 to 3 μ and 50 to 100 μ dia particles, indicating different scavenging mechanisms. Small particles are removed preferentially from aerosols during the liquid-vapor-solid phase transition, and large particles by aerodynamic capture. Large differences in the D content of snow from separate snowfalls can be explained by the differing origins and trajectories of moisture-bearing air parcels. (BBB)

38107 MEASUREMENT OF THE MOBILITY AND THE DIFFUSION COEFFICIENT OF ULTRAFINE RADIOACTIVE PARTICLES IN THE AIR. Huertas, M. L.; Marty, A. M.; Fontan, J.; Blanc, D. (Centre de Physique Atomique et Nucleaire, Toulouse). J. Atmos. Sci., 26: 274-80(Mar. 1969).

Mobilities and diffusion coefficients of the decay products of a natural radioactive gas, ^{220}Rn and of an artificial radioactive gas, ^{85}Kr, were measured in filtered air. The study of the mobility of these radioactive ions demonstrated the presence of 4 groups of ions, ThB^+ and Rb^+. The theoretical mobility of a nonagglomerated Rb^+ ion in air would be 2.4 $cm^2/sec^{-1}V^{-1}$. The measured mobilities of ions (group I), ThB^+ or Rb^+, appeared to be slightly lower than the theoretical mobilities. It is believed that ions (group I) are not the primary, nonagglomerated ions, because they are older than 10^{-1} sec. The maximum value of the ion radius is about 12 Å (group IV). Under the conditions used, the concentration of ions whose radii > 12 Å was less than 2% of the total concentration of ions. The study of the evolution of the fastest ions (group I) showed that these ions undergo a slow transformation of about 1 sec, accelerated by the irradiation of the gas. Several experiments were done with Ar, O_2, and N_2 where the concentration of radioactive gas was 6 atoms/l and the concentration of impurities was of the same order as that of the 99.995% pure initial mixture (20% O_2, 80% N_2, by volume). The results gave essentially the same values for the mobilities, the relative importance of the different groups of ions being the same in O_2 as in N_2. In Ar, however, ions (group I) disappear faster. (BBB)

38108 PRIMORDIAL RARE GASES IN THE ATMOSPHERE OF THE EARTH. Wasson, J. T. (Univ. of California, Los Angeles). Nature (London), 223: 163-5(July 12, 1969).

A review is given of data on the presence of rare gas nuclides (Ne, Ar, Kr, and Xe) in stony meteorites, which seem to indicate two distinct components, one with relative abundances similar to those in the earth's atmosphere, and the other with abundances closely resembling the mean values for the solar system. The origins of these two components are discussed. It was concluded that the simplest explanation of the rare gas distribution in the earth's atmosphere is that these gases were trapped in the solid particles from which the earth was formed, with subsequent release. The similarity between the meteoritic and terrestrial distribution of the rare gases indicates that negligible fractionation has occurred during outgassing of the earth, and that outgassing is now nearly complete. (UK)

38109 AREAL DISTRIBUTION OF THE CALCULATED RADIATION BALANCE IN HUNGARY. Major, Gyorgy; Tarkanyi, Zsuzsanna. Idojaras, 73: No. 2, 81-5(Mar.-Apr. 1969). (In Hungarian).

The values of global radiation for the 1901 to 1950 period as well as the relations between total daily global radiation and sunshine duration were evaluated in order to obtain an indirectly established radiation balance distribution over Hungary. The calculations involved the determination of the coefficient characterizing the long-wave balance, i.e., the radiation and reradiation. Distribution maps for the twelve months of the year are included. The data obtained agree reasonably well with those published in the literature for Czechoslovakia and the Ukraine. (12 references) (JPRS)

38110 FALLOUT OVER AUSTRALIA FROM NUCLEAR WEAPONS TESTED BY FRANCE IN POLYNESIA FROM JULY TO SEPTEMBER, 1968. Gibbs, W. J. (Commonwealth Bureau of Meteorology, Melbourne); Moroney, J. R.; Stevens, D. J.; Titterton, E. W. Aust. J. Sci., 31: 383-8(May 1969).

An Australian-wide 26-station survey was made of fresh fission products in fallout from French nuclear weapons tests in the South Pacific in July to September 1968. All data on total beta activity in fallout deposition are given. Daily samples from July to December 1968, by continuous deposit, on horizontal gummed film were complemented by weekly air filter sampling for specific fission products at 5 stations. Onset of the main fallout from such tests occurred after 10 to 15 days and most deposition was complete within about 35 days but in two high yield tests (megaton range) the times were longer. External gamma doses, integrated to infinity, were computed from measured daily total beta activities, corrected for decreased sampling effectiveness due to rain but with no account taken of reduction of active whole body doses, due to weathering, shielding, etc. The doses were very small by comparison with annual background radiation. Doses from 1968 fallout were smaller than those from 1966 tests, which were considered not significantly hazardous to the Australian population. A summary is given of results of sampling for ^{131}I in milk in eight production centers. There was no significant contribution from the high yield tests. In the major population centers doses to thyroid would be less than the 4% of the dose limit in the National Radiation Advisory Committee's radiation protection guide. (Australia)

38111 DEBRIS FROM THE SIXTH CHINESE NUCLEAR TEST. Persson, G.; Sisefsky, J. (Research Inst. of National Defence, Stockholm). Nature (London), 223: 173-5(July 12, 1969).

A test conducted on June 17, 1967, exploded at a height of <14 km and appeared to involve a few megaton thermonuclear devices fired at the Lop-Nor test site. No signs of activity from this test were found until 56 days after the event, at which time the activity was due to single hot particles (~2.3 μm and ~ 700 β dpm). Smaller particles eventually appeared and the number per sample increased to not more than a few tens per 100 kg air, even in high altitude samples. The debris continued to appear until Jan. 1968, when the seventh Chinese test masked the picture. Because of the long time lapse between explosion and sampling, only a few γ-emitters could be determined (mainly $^{95}Zr-Nb$, ^{141}Ce, and ^{144}Ce). A description is given of the observed particles, which resembled those from earlier Russian thermonuclear tests. The specific activity was among the highest ever found, and it appeared that the particles had fallen from greater altitudes than normal. From microbarographic investigations it appeared that the device exploded at a comparatively low altitude and that the bulk of the debris was carried to a high altitude by the rising fire-ball. (UK)

38112 SOME REGULARITIES IN THE DIURNAL AND ANNUAL VARIATIONS OF THE RADIATION BALANCE. Lingova, St. (Inst. for Hydrology and Meteorology, Sofia). Idojaras, 73: No. 2, 76-80(Mar.-Apr. 1969). (In Russian).

Hourly data of the radiation balance obtained during the 1960 to 1964 period in daytime at Sofia Meteorological Observatory were processed. The data were grouped according to clear, moderately cloudy, and overcast days since in daytime the radiation balance is mainly influenced by global radiation and thus, in turn, is mainly influenced by the solar elevation angle and nebulosity. Several regularities were pointed out, one of them indicating that the radiation balance of the active surface is dependent on the temperature gradient existing between the surface and the two-meter level. (JPRS)

38113 A CONTRIBUTION TO THE EVALUATION OF INTEGRAL BETA ACTIVITY OF THE ATMOSPHERIC FALL OUT IN THE TOWN OF OLOMOUC IN 1966. Havlickova, A.; Cabak, I.; Vystavel, B. Jad. Energ., 15: 27-9(1969). (In Czech).

Measurements of the beta activity of atmospheric precipitation in the mountains of Czechoslovakia from January 1966 through January 1967, are reported. Values of the beta activity for the given period showed that dusts and smoke in urban localities have no effect on the radioactivity in precipitation. (tr-auth)

38114 A TECHNIQUE FOR DEMONSTRATING C_{max} OF A PLUME USING TRITIATED MOISTURE. Sax, N. I.; Daly, J. C.; Gabay, J. J. (New York State Dept. of Health, Albany). Nucl. Appl. Technol., 7: 106-12(July 1969).

The stack effluent of a nuclear fuel reprocessing plant would be expected to contain sufficient tritium to serve as a radioactive tracer for the plume. In order to make use of this built-in tracer, a silica gel sampler for tritiated moisture was developed, which permits large-scale sampling. An intensive study of the area surrounding Nuclear Fuel Services, Inc. was undertaken during the summer of 1967 to determine experimentally the maximum concentration (C_{max}) of the stack effluent using tritiated moisture as the tracer. Sampling legs that radiated from the stack were established. During a two-month period >700 samples were collected on seven sampling legs. The average tritium radioactivity on the sampling leg northwest of the plant (leg G) exceeded 1000 tritium units (TU) 71% of the time for the 28 sampling periods studied. In 11 of 28 cases a maximum concentration of >3000 TU occurred. It was definitely demonstrated that a C_{max} can be determined by tracing with tritiated moisture. Based on experimental C_{max} values, an estimate of the emission rate, Q, was made under various meteorological conditions. The possibility of a secondary source of tritiated moisture influencing measurement of stack-emitted tritium was considered. (auth)

38115 FRACTIONATION OF BOMB-PRODUCED RARE-EARTH NUCLIDES IN THE ATMOSPHERE. Thein, Myint; Beck, J. N.; Johnson, Horace; Cooper, W. W.; Reynolds, M. A.; Clark, R. S.; Baugh, J. O.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Environ. Sci. Technol., 3: 667-70(July 1969).

The phenomenon of atmospheric fractionation of fission products occurs on a world-wide scale when fresh debris from a nuclear explosion travels eastward and circles the earth. Among the rare earth radionuclides, ^{91}Y and ^{141}Ce were often depleted relative to other rare earths in fallout samples collected several days after the Chinese nuclear detonation of December 24, 1967. This is due to the existence of gaseous precursors in the mass 91 and 141 chains. Pronounced fractionation phenomena were also observed for fission products at mass numbers A = 89 (Sr), A = 131 (I), and A = 140 (Ba). (auth)

38116 AIR POLLUTION. SECOND EDITION. VOLUME I. AIR POLLUTION AND ITS EFFECTS. Stern, Arthur C. (ed.). Environmental Science. An Interdisciplinary Monograph Series. New York, Academic Press, 1968. 712p. $32.50.

A separate abstract was prepared for one chapter. The remaining chapters include information not within scope of NSA on the extent of air pollution, gaseous pollutants, viable and nonviable particles in the air, and atmospheric reactions and scavenging processes. (R.C.K.)

For an abstract of the individual chapter see: 38117.

38117 SOURCES OF RADIOACTIVE POLLUTION. Eisenbud, Merril (New York Univ. Medical Center, N. Y.). pp 121-47 of Air Pollution. Second Edition. Vol. I. Air Pollution and Its Effects. Stern, Arthur C. (ed.). New York, Academic Press, 1969.

The terrestrial and cosmic ray-induced origins of natural radioactivity are discussed. Properties of fission and activation products are given. The effects of nuclear reactor operation and the reprocessing of spent reactor fuels on atmospheric contamination are summarized. The effects of nuclear weapons testing and aerospace applications of nuclear energy on the amounts of radioactivity in the atmosphere are also discussed. (R.C.K.)

38118 AIR POLLUTION. SECOND EDITION. VOLUME II. ANALYSIS, MONITORING, AND SURVEYING. Stern, Arthur C. (ed.). Environmental Science. An Interdisciplinary Monograph Series. New York, Academic Press, 1968. 701p. $35.00.

A separate abstract was prepared for one chapter. The remaining chapters include information not within scope of NSA on air sampling and quantity measurement, analysis of organic and inorganic gaseous and particulate pollutants, odor and its measurement, meteorological measurements, air quality monitoring, production of controlled atmospheres, source inspection, monitoring, registration, and testing, and objectives and methods for community air pollution surveys. (R.C.K.)

For an abstract of the individual chapter see: 38119.

38119 MONITORING AIRBORNE RADIOACTIVITY. Schulte, Harry F. (Los Alamos Scientific Lab., N. Mex.). pp 393-424 of Air Pollution. Second Edition. Vol. II. Analysis, Monitoring, and Surveying. Stern, Arthur C. (ed.). New York, Academic Press, 1968.

Equipment and methods for monitoring airborne radioactivity are presented. The use of filters, impactors, impingers, precipitators, and settling trays for radioactive particulate sampling and quantitation is described. Methods for sampling and quantitation of iodine, tritium, noble gases, radon and thoron, and carbon-14 dioxide and sulfur-35 dioxide are discussed. Information on survey techniques, particle size analysis, and standards is also discussed. (R.C.K.)

38120 AIR POLLUTION. SECOND EDITION. VOLUME III. SOURCES OF AIR POLLUTION AND THEIR CONTROL. Stern, Arthur C. (ed.). Environmental Sciences. An Interdisciplinary Monograph Series. New York, Academic Press, 1968. 886p. $47.50.

A separate abstract was prepared for one chapter. The remaining chapters include information not within scope of NSA on mobile and stationary combustion sources, petroleum refinery emissions, efficiency, application, and selection of collectors, methods of source control, nuisance abatement by combustion, air pollution control legislation, administration, and standards, public information and education, and air pollution literature resources. (R.C.K.)

For an abstract of the individual chapter see: 38099.

38121 ADSORPTION OF RADIOACTIVE IODINE VAPORS FROM AIR. Nakhutin, I. E.; Smirnova, N. M.; Laushkina, G. A.; Loshakov, G. A. At. Energ. (USSR), 26: 390-1(1969). (In Russian).

In spite of apparent large adsorption coefficients for iodine, experiments on the dynamic adsorption of iodine show that in a charcoal adsorption column there is a sharp decrease of iodine concentration in the initial portion of the column with a less efficient adsorption of iodine in the remaining parts of the column. An expression for the concentration distribution along the column length is given for spherical granules under steady-state conditions. This equation was compared with experimental results from the dynamic adsorption of iodine from air in charcoal columns at 20°C with a partial iodine pressure of 10^{-8} to 10^{-9} torr and a linear gas flow of 30 to 50 cm/sec. The shape of the dynamic adsorption curve indicates the presence of three iodine-containing components in the gas mixture. The first component is molecular iodine with a very high adsorption coefficient of 9 to 15 cm^{-1} (difference in concentration per unit length). Hydrogen iodide with an adsorption coefficient of 6.6 could belong in this group. The second component with an adsorption coefficient of 0.79 cm^{-1} consisted of iodinated hydrocarbons which could be decomposed to molecular iodine by heating on an oxide catalyst at 750°C. The composition of the third component with an adsorption coefficient of 0.08 to 0.3 cm^{-1} could not be established. This component was observed only at high air humidities, and could be made to disappear by reducing the relative humidity below 30%. (TTT)

38122 RADIOACTIVE FALLOUT IN AIR DURING 1966-67. Hla Pe; Chit Khaing (Arts and Science Univ., Rangoon). Union Burma J. Sci. Technol., 1: 369-73(Aug. 1968).

Measurements of airborne activity before and after the monso of 1966 and 1967 are reported. A rise in total beta activity was observed during November 1966. (auth)

38123 VOLATILITY OF ^{210}Po(RaF) IN AIRBORNE DUSTS AT VARIOUS TEMPERATURES. Abe, S.; Abe, M. (National Inst. of Radiological Services, Anagawa, Japan). Health Phys., 17: 340-1(Aug. 1969).

A designed sublimation method was applied to obtain some information on the volatility of natural ^{210}Po contained in airborne dusts. (UK)

Mineralogy and Exploration

Refer also to abstracts 38103 and 38303.

38124 GEOLOGIYA I VOPROSY GENEZISA ENDOGENNYKH URANOVYKH MESTOROZHDENII. (Geology and Problems of Genesis of Endogenic Uranium Deposits). Vol'fson, F. I. (ed.). Moscow, Izdatel'stvo Nauka, 1968. 472p.

Geologic structures, properties, and the mineralogical composition of ores were examined. The genesis of different types of endogenic uranium deposits in faults and mineralized fields was studied. The geology and genesis of the principle types of radioactive deposits are discussed. The results of theoretical investigations in the field of geology of uranium deposits and the conditions of their formation are summarized. Criteria for prospecting of commercial ore deposits are described. (tr-auth)

38125 OUTLOOK FOR URANIUM. Gunning, Gerald D.; Springsteen, David F.; Winger, John G. New York, The Chase Manhattan Bank, N. A., 1969. 24p.

Study results indicate that uranium producers in the United States and other countries can develop adequate U_3O_8 reserves to meet world needs through 1980. It also seems reasonable that these reserves can be brought to market as needed at a price, in constant dollars, of $10 per pound or less. This should be sufficient (assuming nuclear plant capital costs do not get out of hand) to enable the industry to compete effectively with other fuels for the energy needs of the electric utility industry. A potential oversupply situation and therefore heightened price competition in sales activities for requirements in the mid-seventies could also develop, but producers may attempt to resist this trend by delaying investment in new mines and mills. Average prices for U_3O_8, however, should range between $8 and $10 per pound in terms of constant dollars during the 1968/1980 period. (auth)

38126 PRODUCTION, RESERVES, AND FUTURE SOURCES OF URANIUM. Kostiuik, J. (Denison Mines Ltd., Toronto). Can. Mining Met. Bull., 62: 609-13(June 1969).

The outlook for uranium resources is discussed and brief comments made on the measures needed to meet market objectives. Areas of recent exploration interest are also considered. (auth) (Canada)

38127 STATUS AND FUTURE PROSPECTS OF GOLD AND URANIUM ORE PRODUCTION IN THE GREATER WITWATERSRAND. Reh, Herbert. Z. Angew. Geol., 14: 99-104(Feb. 1968). (In German).

Geological and geothermal characteristics, locations, and composition of U ores in the greater Witwatersrand of South Africa are described. For the period 1954 to 1965 production of U ore in the previously mined areas ranged up to 22,000 tons annually. The ore content was from 258 to 383 g/ton of U_3O_8, with production of from 2660 to 5650 tons/yr. It has declined since 1966 because of unprofitability. Various factors that have affected U_3O_8 mining in the greater Witwatersrand area are discussed. These include price levels and annual production. Many areas with low concentrations of U_3O_8 were uneconomic to mine except where Au was the primary product. Values for the U_3O_8 production from 1947 to 1966 were used to project future production until 1987, taking into account increased production costs. It was concluded that U_3O_8 production would become more important than at present although reserves may drop very much by the year 2000. (BBB)

Oceanography

Refer also to abstract 38130.

38128 URANIUM, THORIUM, AND RADIUM IN OCEAN WATER AND DEEP-SEA SEDIMENTS. Heye, Dietrich (Bundesanstalt fuer Bodenforschung, Hanover). Earth Planet. Sci. Lett., 6: 112-16(May 1969).

It was found from the data of 25 deep-sea cores that the U/Th ratio of sediments is nearly constant at a low $CaCO_3$-content. This result and reflections about some other points have led to the assumption that U and Th are being transported into the sediment through the intermediary of minerals. During the transport U (preferably ^{234}U), Ra, and some Th are leached by ocean water. This model provides for interpretation of the activity ratio $^{234}U/^{238}U < 1$ in deep-sea sediments with low carbonate content as well as the activity ratio $^{228}Th/^{232}Th \sim 15$ in ocean water. Likewise a part of the ^{226}Ra excess (compared with the Io in solution) may be caused by that leaching. (auth)

38129 STATE OF ULTRASMALL QUANTITIES OF ^{144}Ce AND ^{91}Y IN SEAWATER. Spitsyn, Vikt. I.; Bernovskaya, R. N.; Popov, N. I. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 185: 111-14(1969). (In Russian).

The transformations of ionic forms of cerium-144 and yttrium-91, which were introduced into seawater taken from different depths of the Pacific Ocean, were followed in order to determine the migration ability of the rare earth elements. The behavior of ^{144}Ce and ^{91}Y in turbid waters obtained from the surface layer of bottom deposits at a depth of 5173 m was investigated to determine the complexing effect of dissolved organic matter. A suspended state and a dissolved state of the radionuclides were differentiated by filtration through an ultrafine membrane (pore size of 0.1 microns). All water was filtered through this membrane filter before introduction of the radioisotope into a small amount of 0.1 N HCl. The amount of radioactivity retained by the filter was <10% at a pH of 4.0 or lower, and increased to about 40% at a

pH of 6.0 and higher. The possibility of true colloid formation with phosphate ions was not excluded (<0.1 microns in size). The rare earth ions may also be present in dissolved form as complexes. The content of suspended ^{91}Y goes through a minimum in seawater taken at depths of 100 and 500 m, where the ^{91}Y is completely soluble for all practical purposes. A differentiation between ^{144}Ce and ^{91}Y takes place in seawater with ^{144}Ce preferentially precipitated and ^{91}Y remaining in solution. (TTT)

Seismology

38130 MODELING OF SEISMIC SIGNALS FROM LARGE UNDERWATER EXPLOSIONS TO PREDICT THE SPECTRA AND COVARIANCE FUNCTIONS. Plutchok, R.; Broome, P. (Earth Sciences, Alexandria, Va.). Bull. Seismol. Soc. Amer., 59: 1137-47(June 1969).

A model is presented which makes it possible to accurately predict the power spectrum and the covariance function of seismic signals generated by large underwater shots. It is shown by comparison of predicted and measured data for several large underwater explosions that the spectrum and covariance depend almost entirely on parameters such as source depth, water depth and first bubble pulse period. It is further demonstrated that averaging of the spectra from widely dispersed seismic stations for a given signal is a useful method for reducing nonsource-related effects. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 38094, 38095, and 38569.

38131 SURVIVAL AND THE BOMB: METHODS OF CIVIL DEFENSE. Wigner, Eugene P. (ed.). Bloomington, Ind., Indiana University Press, 1969. 315p. $7.50.

Discussion is presented on: the objectives of civil defense; the American public and civil defense; psychological problems of A-bomb defense; human behavior in disaster: the siege of Budapest; offensive weapons and their effectiveness; medical and ecological effects of nuclear weapons; civil defense abroad in review; active and passive defense; improved shelters and accessories; decontamination; economic recovery; recovery of basic industries; and societal recovery. (J.C.W.)

38132 EXCAVATION WITH NUCLEAR EXPLOSIONS. Parate, N. S. (Ecole Polytechnique, Paris). Mines Met., No. 4, 113-15 (Apr. 1969). (In French).

A description of the industrial applications of nuclear explosives for underground excavations and craters is presented. Some experimental relations are given. The production of electric energy from the explosion, and the subsequent use of the energy for mining of minerals and petroleum are described. Safety from radioactivity and seismic wave damage is discussed. It is concluded that the enormous power from nuclear explosions, with a cost per cubic meter all the lower because the power is very great, permits a level of operation inaccessible with conventional explosives. (J.F.P.)

Facilities and Equipment

Refer also to abstracts 38175, 38200, 38215, 38229–38231, 38237, 38278, 38343, 38352, 38362, 38373, 38377, 38720, 38923, 38942, 38954, 38982, 39398, 39411, 39412, 39419, and 39592.

38133 (AI-AEC-12800) FISSION PRODUCT BEHAVIOR LOOP FACILITY DESCRIPTION. Guon, J. (Atomics International, Canoga Park, Calif.). June 15, 1969. Contract AT(04-3)-701. 30p. Dep. CFSTI.

A small forced circulation loop for use in studying the behavior of fission products in Na is described. Information is included on loop design and construction, and on instrumentation and control. (J.R.D.)

38134 (APED-5736) GUIDELINES FOR DETERMINING SAFE TEST INTERVALS AND REPAIR TIMES FOR ENGINEERED SAFEGUARDS. Jacobs, I. M.; Marriott, P. W. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 1969. 53p.

Engineered safeguard systems are standby systems. They are tested periodically to assure that they are operable and returned to standby status. Because there is redundancy, one failed system does not fail the function. Repair on the failed system during continuous plant operation is permissible and desirable provided overall plant safety is not degraded. A formula is developed for determining the time allowable for repair so that the expected level of safety is maintained. For example, if one of three redundant systems is found to be failed at test, a repair time not to exceed one-half the normal test interval is allowable. A special rule is developed to determine the safest mode for the plant while engineered safeguards relating to the loss-of-coolant accident are undergoing repair. In general, if the estimated repair time is very long, it is safest to place the plant in the shutdown mode. If the repair time is short, continued steady-state operation during repair is the safest mode. Steady state operation is almost always the safest mode for repair time less than approximately eight hours. A basis is developed for estimating the unavailability of redundant systems based on the failure rates and repair times of the components, and the interval between system tests. Unavailability may be significantly reduced if the tests on the various systems are distributed uniformly throughout the test interval rather than being conducted one immediately following another. These rules, where applicable, are used to aid in setting allowable test intervals and repair times for essential equipment as documented in the various BWR technical operating specifications. (auth)

38135 (BNWL-1058, pp 10.1) ATR GAS LOOP OPERATION AND MAINTENANCE. Bement, A. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Summaries are presented on loop support activities, tube fabrication for in-pile use, instrument development, and heat exchanger fabrication. (J.R.D.)

38136 (CONF-680625-6) BOILERS FOR NUCLEAR POWER STATIONS. Worley, N. G. (Babcock and Wilcox Ltd., [London] (England)). [1968]. 14p. Dep.

From BNX/BNF Nuclear Power Meeting, Copenhagen, Denmark.

The general considerations taken into account in the design of boilers for nuclear power stations are reviewed. Specific problems related to tube leakage, coolant radioactivity, heat transfer, corrosion, vibration, and system stability and control are briefly discussed. (UK)

38137 (CONF-681064-6) IRRADIATION TESTING EQUIPMENT. Tilbe, H. E. (Bristol Aerojet Ltd., [Banwell] (England)). [1968]. 16p. Dep.

From British Nuclear Forum and Deutsches Atomforum Meeting, Frankfurt am Main, Germany.

Irradiation experiment requirements for nuclear power stations are outlined, and the development of in-pile heaters, high temperature thermocouples, boiling water loops, and uni-axial creep and stress rupture rigs is described. (UK)

38138 (CONF-690401–, pp 173-92) APPLICATION OF AN IMAGE PROCESSING SYSTEM TO FRAGMENTATION STUDIES. Butler, Margaret K. (Argonne National Lab., Ill.).

Fragmentation experiments are described. In these experiments single drops of materials such as molten tin, lead, bismuth, and UO_2 are dropped into reactor coolants such as water and sodium. The degree of fragmentation that ensues is a function of the drop height and/or drop size, and the temperature of the molten metal and the quenching medium. Measures of this fragmentation were made. The information is used in reactor safety heat transfer calculations. The CHLOE hardware and image processing software system was used to facilitate chemical engineering studies of physical and chemical interactions between reactor structural and fuel materials and reactor coolants. In the experiments, a piece of tin of approximately 0.4 g in weight and with a spherical surface area of 0.6 cm^2 was used. The tin was heated to a specific temperature in the 250 to 600°C range in a quartz dropper positioned in a small electric resistance furnace. A single drop was visually observed to fall from a height of one to four feet into room temperature water when a slight overpressure was applied to the dropper. Particle size measurements were then made on the metal fragments by sieving through wire cloth. (R.C.K.)

38139 (CONF-690401–, pp 503-18) COMPUTATIONAL METHODS IN SOLID MECHANICS AND STRESS ANALYSIS. Rashid, Y. R. (Gulf General Atomic, Inc., San Diego, Calif.).

Progress made in the various areas of the finite element method for the solution of problems in solid mechanics and stress analysis is discussed. Computational problems in solid mechanics generally begin with identification of a structure's configuration and its environment. The former defines the geometry of the structure, which may be one of many types, such as a beam, plate, shell, or general three-dimensional solid. The latter, the environment, imposes on the geometry a set of governing equations which consist of strain-displacement relations, constitutive equations, compatibility relations, boundary conditions, and equilibrium equations. Both the geometry and the environment strongly influence the selection of computational procedure appropriate to the problem. The development of computational methods in solid mechanics has emphasized variational procedures. The finite element method evolved as an extension of the Rayleigh-Ritz procedure and has become the most extensively used numerical technique in computational mechanics. With the aid of the digital computer, the development of this method has progressed rapidly, and the method has come to represent the accepted state of the art in most areas of stress analysis. The major factor responsible for this rapid growth is the method's versatility in treating arbitrary geometries, boundary conditions, and material inhomogeneities. (auth)

38140 (CONF-690401–, pp 542-60) NUMERICAL ANALYSIS OF TWO-DIMENSIONAL, DYNAMIC, THERMAL STRESSES IN A HOLLOW CYLINDER. Reuscher, J. A.; Scott, M. R. (Sandia Labs., Albuquerque, N. Mex.).

The finite difference technique for solving the dynamic thermoelastic displacement equations is described. The technique provides good agreement between calculated results and measured values. The program CADETS can perform about 3.6×10^5 mesh point calculations of u and v per minute of computer time on the CDC-6600. Hollow cylinders with varying lengths and diameters have been successfully run with CADETS as long as stability was maintained by the proper choice of $\Delta t/\Delta r$ and $\Delta z/\Delta r$. (auth)

38141 (KAPL-P-3837) THEORETICAL AND EXPERIMENTAL ANALYSIS OF A THERMAL STRESS PROBLEM IN TUBE SHEET DESIGN. Slot, Thomas (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 1969. Contract W-31-109-eng-52. 45p. (CONF-690906-1). Dep. CFSTI.

From 1st International Conference on Pressure Vessel Technology, Delft, Netherlands.

Stresses produced in the tube sheet of heat exchangers of the U-tube type by a temperature differential across the divider lane between inlet side and outlet side are examined. Results reported from photoelastic experiments show that the highest stresses occur within the first few rows of holes adjacent to the divider lane and that the distribution of stresses tends to be repetitive from hole to hole along these rows. Analytical procedures are presented for evaluating stresses in thin and thick tube sheets. Good agreement is demonstrated between predicted and measured stresses for thick tube sheet models. (auth)

38142 (N-69-18734) RADIATION PROTECTION STUDY FOR PHOTOGRAPHIC SPACE FILM. (Chrysler Corp., New Orleans, La. Space Div.). Jan. 17, 1969. Contract NASw-1741. 57p. (NASA-CR-100016). CFSTI.

A cobalt-60 source was used to irradiate several types of space photographic film. From the data obtained, characteristic curves were drawn for these films, and a proton-gamma equivalence determined. The effects of variations in the development processing parameters were investigated, and the feasibility of reduced film storage temperature was studied as a means to inhibit film fogging in space. (auth) (STAR)

38143 (RFP-1354) FLAMMABILITY OF LEADED DRY-BOX GLOVES. Johnson, Thomas C.; Lindsay, John W. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). June 9, 1969. Contract AT(29-1)-1106. 8p. Dep. CFSTI.

An investigation of the flammability of dry-box gloves reveals that a potential fire hazard exists in the use of leaded dry-box gloves in nitric acid environments. (auth)

38144 FUEL PIN SPACERS. Crandall, Gary J. (to U. S. Atomic Energy Commission). U. S. Patent 3,463,703. Aug. 26, 1969.

An assembly is described which comprises a plurality of parallel strips having a series of flat sections transverse of and between rows of fuel pins. The flat sections are bent with respect to each other to form a row of V's connected at their edges, each V on either side of the strip containing a fuel rod. Each flat section has two protuberances, one on either side and extending in opposite directions to support the fuel element on either side of the strip. (AEC)

38145 VENTED FUEL PIN. Germer, John H. (to U. S. Atomic Energy Commission). U. S. Patent 3,459,636. Aug. 5, 1969.

A device incorporated in the upper end of a vented-type nuclear fuel element is described which permits outward leakage of fission product gases and prevents inward leakage of coolant. This is accomplished by venting gases to the upper end of the fuel pin which is at a lower external pressure than in the vicinity of the bottom of the plenum. In addition, venting at the top of the plenum eliminates a coolant level variation in the plenum caused by pressure variations. Also, the device includes means for preventing air and moisture from getting into the fuel element and fuel from escaping during initial handling. (AEC)

38146 IMPROVEMENTS IN OR RELATING TO THE CIRCUMFERENTIAL STRESSING OF CONCRETE PRESSURE VESSELS. Portas, John Richard; Carter, Rodney Richard (to Taylor Woodrow Construction Ltd.). British Patent 1,158,374. July 16, 1969. Filed Mar. 7, 1967.

Means are described for anchoring an end of a prestressing wire in a circumferential trough or channel of rectangular cross section in or on the outer surface of a cylindrical concrete pressure vessel. A socket is located in a side wall of this trough and a peg is provided to which the end of the wire may be attached, the peg being supported within the socket so as to allow sliding movement from a projected position, which will allow attachment of the wire to an anchoring or retracted position in which the wire and peg will be housed within the socket, clear of the trough. The peg may be forced into the socket by means of an hydraulic jack or ram. Various alternative arrangements are described. (UK)

38147 IMPROVEMENTS IN OR RELATING TO CIRCUMFERENTIAL STRESSING OF CONCRETE PRESSURE VESSELS. Portas, John Richard; Carter, Rodney Richard (to Taylor Woodrow Construction Ltd.). British Patent 1,156,245. June 25, 1969. Filed Mar. 7, 1967.

A circumferential stressing system is described for effectively anchoring the prestressing wires, and also for allowing the obtaining of uniform wire layers, wherein the turns of wire are even and lie in close side by side relationship without crossing. An anchor plate is provided which is adapted to be laid in a circumferentially extending rectangular cross-section trough or channel in the system of prestressing wires, and to be positively located against movement lengthwise of the channel. The plate has a number of grooves in spaced parallel relation such that they extend lengthwise with regard to the channel when the plate is in position in the channel, the arrangement being such that with one end of a wire anchored in a groove in the plate the wire may be wound around the vessel with successive turns passing across the top of the plate, the other end of the wire being anchored in another groove in the plate. Various alternative arrangements of the anchor plate are also described. (UK)

38148 FURNACE FOR THE PRODUCTION OF ^{131}I. (to Commissariat a l'Energie Atomique). French Patent 1,423,740. Filed Oct. 2, 1964.

A furnace is described for the production of ^{131}I by heating irradiated Te and the removal of the vaporized I by a neutral gas. The furnace comprises a tubular muffle having heating means, an inlet passage for the neutral gas at one end of the muffle, a gas discharge passage with heating means at the other end of the muffle, an orifice for the introduction of irradiated Te, a closure plug for the orifice, means for moving the plug parallel to the muffle axis, and means for pivoting the plug transversely to clear the orifice. The moving and pivoting means preferably are pneumatic jacks. The muffle is heated by a number of separately supplied electrical windings and is surrounded by a heat insulating material. All the outside surface can be cooled by water, preferably flowing in a number of separate jackets. (NPO)

38149 FLUID-BED VOLATILITY COMPONENT, ENGINEERING FEASIBILITY, AND SCALE-UP STUDIES AT THE OAK RIDGE GASEOUS DIFFUSION PLANT. Smiley, S. H.; Pashley, J. H.; Brater, D. C. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Ind. Chim. Belge, 32: Special No., (Vol. 1), 781-6(1967).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

Fluid-bed volatility processes for recovering uranium and plutonium from spent nuclear reactor fuels appear promising because of the relatively low process waste volumes, excellent probable decontamination, and apparent mitigation of criticality problems. Conceptual plant studies and evaluation of plant-scale component designs are being performed. Crucial equipment items, including the fluid-bed reactors, will be tested on a semiworks scale using nonirradiated, uranium materials to confirm design assumptions and to evaluate the scale-up problems. Peripheral equipment items, such as gas compressors, piping connectors, valves, filter media, sorbent trapping systems, and solids transfer equipment, are included in the test plans. Preliminary results are given for filter media compressor, and connector tests. Materials of construction studies are discussed. (auth)

38150 CHAMBER FOR THE INVESTIGATION OF THE MOESSBAUER EFFECT AT HYDROSTATIC PRESSURES UP TO 10 KBAR. Panyushkin, V. N. (Inst. of Physics of High Pressures, Moscow). Prib. Tekh. Eksp., No. 2, 193-4(Mar.-Apr. 1969). (In Russian).

A chamber capable of operating at an increased range of pressures, with a simple method of producing the pressure, and with provisions for both the source and absorber to be under pressure is described. (tr-auth)

38151 DESIGN FOR LABORATORY FACILITIES WITH A NEUTRON GENERATOR. Kawakami, Hiroyasu; Oda, Toshiyuki (Kyushu Univ., Fukuoka). Onken Kiyo, 20: No. 3, 198-204(Sept. 1968). (In Japanese).

Laboratory facilities including a neutron generator were planned for attachment to the radioisotope research facilities which had been already set up in 1961 on the campus of Kyushu University. The maximum value of a neutron flux is 10^{10} neutrons/sec. Protection for humans against neutrons is described. Magnesium oxychloride cement was used as a shielding material at specified thicknesses, part of the wall 1 meter; the other part, 2 meters. As a result, the dose to the outside of the wall was reduced to less than the maximum permissible. (NSA of Japan)

38152 AXIAL FLOW VAPOUR-LIQUID SEPARATOR. Cochran, John Thomas (to General Electric Co.). British Patent 1,157,877. July 9, 1969. Priority date July 30, 1965, United States.

A vapor-liquid separator is described comprising an elongate vortex tube having an inlet opening for a vapor-liquid mixture at

one end and an outlet opening at the other end. Adjacent the inlet opening a means is provided for imparting to the entering vapor-liquid mixture a rotary motion sufficient to establish within the vortex tube a vapor vortex surrounded by a liquid vortex. An elongate annular passageway coaxial about the vortex tube extends in a direction from the outlet opening toward the inlet opening, and a passage communicates with the outlet opening of the vortex tube for conducting liquid from the liquid vortex into the elongate annular passageway. A plurality of diffuser blades is disposed in the elongate annular passageway for reducing the velocity of the liquid and increasing its pressure. The vapor-liquid separators are particularly adaptable for use in boiling water nuclear reactors. (J.R.D.)

38153 MACHINE TOOL FOR CUTTING AN ASSEMBLY OF COAXIAL TUBES INTO PARTS, PARTICULARLY THE CHANNELS OF A PRESSURE-TUBE NUCLEAR REACTOR. Bonnet, Georges; Di Piazza, Learco; Junger, Jean-Marie; Leroy, Rene; Mollica, Guido; Monzani, Ermelino (to EURATOM). British Patent 1,157,473. July 9, 1969. Priority date Nov. 23, 1965, Belgium.

A machine is described for use in transversely cutting single tubes or two or more tubes nested one inside another. A sleeve surrounds the tubes to be cut and contacts the tubes by discs allowing sleeve rotation. A vise is provided for holding the tubes. (J.R.D.)

38154 IMPROVEMENTS IN OR RELATING TO VAPOR GENERATORS. (to Fives-Penhoet). British Patent 1,155,869. June 25, 1969. Priority date Nov. 8, 1965, France.

A steam generator is described that is adapted to the various requirements to be met in the equipment of nuclear plants, and characterized in that it consists of identical unitary panels placed side by side comprising a number of identical tubular elements, said panels being grouped into separate identical units constituting each an elementary vapor generator unit. The units are so assembled as to have the shape of a polygonal annulus in a plane at right angles to the axes of the tubular elements. The design includes free spaces between the outer contour of the annulus and the wall of the enclosure in which the units are housed, and in the central portion of said annulus. The free spaces are adapted to receive the supporting structure and permit the passage of the liquid-supply and/or vapor-outlet pipes. This arrangement also permits more uniform distribution of a large number of tubular heat-transfer elements in the enclosure containing the reactor while preserving the passages necessary for the access to the upper portion of the vapor generator system. (J.R.D.)

38155 DEVICE FOR THE DECONTAMINATION OF IRRADIATED ARTICLES. (to Commissariat a l'Energie Atomique). French Patent 1,444,128. Filed May 18, 1965.

A device for the decontamination of irradiated articles is described, which comprises a tunnel provided with a gate permitting the tunnel to be hermetically closed, a support for the articles to be decontaminated which is movable through the length of the tunnel, a plurality of spray nozzles which are suspended from the ceiling of the tunnel and allows the sprinkling of a suitable solvent, e.g., NaOH, HNO_3, and/or water vapor on the surface of the articles, a drain for collecting and discharging the used solvent into a tank provided with means to purify the solvent, and a system for recycling the purified solvent. (NPO)

38156 FLUID VALVE ASSEMBLY. Gilbert, Ronald Albert (to Rolls-Royce Ltd.). British Patent 1,151,826. May 14, 1969. Filed Aug. 30, 1967.

Reference is made to a fluid valve assembly for operation at high temperatures and pressures, such as in a nuclear reactor installation. A butterfly valve member is mounted within the fluid conduit, and is dimensioned to form an interference fit with the conduit when in the closed position, when it is at the same temperature as the conduit. Ducting is provided for supplying a cooling fluid to the valve member so as to shrink it and allow it to be moved from the closed to the open position. A number of constructional variants of the butterfly valve member are described. The conduit may be provided with a flexible portion to reduce strain. (UK)

38157 SEALING MEANS FOR CONDUITS. Caple, Donald (to Orenda Ltd.). British Patent 1,155,171. June 18, 1969. Filed Apr. 4, 1966.

The object is to provide releasable sealing means compatible with corrosive, radioactive or otherwise contaminated gases and liquids at elevated pressures and temperatures, and to provide sealing means between components where the seal must be continually broken and remade without detriment to the sealing surfaces; also to provide for automated release and replacement of the sealing means. The sealing means comprises a bellows-operated closure plug. The bellows unit is arranged to extend into the bore of the conduit, so that it is subjected to fluid pressure within the conduit and compressed axially so as to expand radially into sealing engagement with the conduit wall. The bellows is disengaged from the wall by exteriorly operable means. The bellows unit is preferably a double unit comprising concentric inner and outer members defining a closed annular chamber, an end plate being provided to close the inner end of the unit. The release means for expanding the bellows unit axially against the fluid pressure may comprise a jack-screw extending through the closure plug, and the latter may be provided with a vent for venting the space within the inner bellows member to atmosphere. (UK)

Heat Transfer and Fluid Flow

Refer also to abstracts 38157, 40314, 40356, and 40499.

38158 (AEEW-M-906) FREON 7-ROD CLUSTER SUBCHANNEL MIXING EXPERIMENTS. Bowring, R. W.; Levy, J. (Atomic Energy Establishment, Winfrith (England)). May 1969. 25p. Dep. CFSTI.

The subchannel thermal-hydraulic characteristics of a 7-rod cluster were measured using boiling Freon-12, modeling water at 1,000 psia. The heated length was 36 in., the rod diameter 0.625 in. and rod gap 0.060 in. The following were determined from the experiments: lateral resistance to cross-flow, the diversion length, cross-flow enthalpy, the fraction of heat retained in the highly rated subchannel, and the turbulent mixing factor, F_m, used in HAMBO. The mixing factor was found to decrease when boiling started, but was then independent of vapor quality, within the experimental error. It also decreased more rapidly with mass velocity in the boiling than in the non-boiling regime. The cross-flow enthalpy was found to be a continuous function with cross-flow and not that of the donor subchannel; the enthalpy appeared to be intermediate between that of the two subchannels but the possibility of steam enhancement could not be discounted. (auth)

38159 (CONF-690401-, pp 519-41) AUTOMATED THERMAL ANALYSIS OF NUCLEAR REACTOR COMPONENTS. Lee, A. Y.; Wells, K. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.).

A description of the computer code AUTOTEM (AUTOmatic TEMperature calculations) is given. It was developed for automating the procedure of modeling and obtaining temperature distributions for a given two-dimensional irregular body with a geometry description such as engineering drawing information as input. The code meshes the solid into a nodal system as required by the heat transfer calculation codes. The nodal system, as generated, is plotted on the SC 4020 data plotter for visual inspection. Temperature distributions are determined using a finite difference numerical solution. From these calculated nodal temperatures isotherms can be plotted for specified temperature values. The AUTOTEM code can handle any two-dimensional or axial symmetrical body consisting of a single material. Time dependent internal heat generation, temperature dependent material thermal properties, and time dependent boundary conditions can be considered. (auth)

38160 (CONF-690401-, pp 561-85) AN EXPLICIT UNLIMITED STABILITY APPROACH TO THE TRANSIENT CONDUCTION-CONVECTION EQUATIONS. Bender, David J. (General Electric Co., [Sunnyvale, Calif. Advanced Products Operation]).

Postulating an axial section of a reactor channel to be the basic nodal unit for transient heat transfer calculations, a finite difference method of calculating the convective heat transfer was developed and checked with sample problems, and found to be superior to existing methods. As the convective model was explicit and not stability limited, it was coupled to an existing explicit, unlimited stability scheme formulated by Levy for the fuel, clad and structural node temperatures. Finally, determination of an effective time step criteria to take advantage of the unlimited stability nature of the equations has resulted in an efficient and accurate nodal model for the analysis of transient heat transfer in a reactor core. (auth)

38161 (CONF-690401-, pp 586-610) TRACK II: A COMPUTER PROGRAM FOR TRANSIENT THERMAL ANALYSIS OF COMPLEX NUCLEAR REACTOR SYSTEMS WITH MULTIPLE PARALLEL AND SERIES FLOW PATHS. Woods, M. D.; Hamlin, L. D. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.).

TRACK II is a digital computer program for transient and steady state thermal analysis of heat generating solids of arbitrary geometry which are cooled by fluid flowing through multiple parallel or

series channels. The hydraulic and heat convection calculations are coupled with finite element heat conduction calculations to determine coolant conditions and material temperature distributions in a single computation. The primary application is to perform detailed thermal analyses of nuclear reactor components such as the reflector, the control mechanism, and fuel cluster assemblies under various operating conditions. A key feature of the program is the versatility of the flow network. Two independent groups of coolant channels are permitted and the channels may be arranged in series and parallel combinations. Additional features include an option for interface conduction between components which are modeled separately and a method to accommodate the effect of fast neutron fluence on component temperature distributions. The formulation for the transient thermal calculations and discussion of the calculational models with emphasis on the application of the capability of TRACK II for thermal, hydraulic analysis of complex systems is presented. The thermal analysis of the reflector system for the XE-PRIME NERVA reactor is presented as an example of this capability. (auth)

38162 (NP-17902) ULTRASONICALLY INDUCED SODIUM SUPERHEAT. Nystrom, Robert Eric (Michigan Univ., Ann Arbor. Cavitation and Multiphase Flow Lab.). May 1969. 211p. Thesis.

The superheat requirements necessary to produce nucleate boiling in liquid sodium as a function of the temperature rise rate for very rapid rise rates as well as a function of the temperature itself were determined. Superheat is defined as the amount that the temperature of the liquid has to be increased above the saturation temperature before nucleate boiling occurs in the liquid. Cavitation was produced in the liquid sodium by utilizing a high temperature ultrasonic vibratory cavitation facility. The facility incorporated a transducer horn assembly which transmits sinusoidal pressure waves at the transducer horn resonant frequency through the liquid sodium. The liquid sodium is contained in a stainless steel cylindrical container which is surrounded by heating coils. Using four transducer horn assemblies of different resonant frequencies, the onset of cavitation in liquid sodium was observed over a frequency range of 14 to 25 kHz. For each frequency the temperature of the liquid sodium was varied from 500 to 1500°F. The onset of cavitation was detected using a stainless steel acoustic probe which detected the noise signal produced by the collapse of the cavitation bubbles. A theoretical expression for the pressure field, which was experimentally verified, was evaluated using the data obtained at the onset of cavitation. It was assumed that spherical vapor bubbles served as nucleation sites for the onset of cavitation. By knowing the change in liquid pressure required at the onset of cavitation, the effective radii of these bubbles were determined. By assuming that these bubbles would also serve as nucleation sites for nucleate boiling in the heat transfer case the superheat required to initiate this nucleate boiling was then calculated using the thermodynamic properties of sodium. It was found that the required superheat decreased for increasing saturation temperature. Using the frequency dependence an equivalent heating rate for the applied superheat was determined. The heating rate is defined as the increase in temperature above the saturation temperature per unit time which is required to produce nucleate boiling in the liquid. For heating rates below approximately 10^6 °F/sec the superheat requirements are essentially independent of heating rate. For heating rates above 10^6 °F/sec the required superheat begins to increase rapidly. Since the conditions used in this experiment were similar to conditions found in sodium cooled nuclear reactors it is felt that the data developed in this study on the behavior of liquid sodium can be used in reactor analysis for conditions which may produce rapid changes in the liquid sodium pressure or temperature. (auth)

38163 (RISO-M-905) PREDICTION OF BURNOUT IN ANNULI. Hartig, A.; Olsen, A.; Hjelm-Hansen, M. (Danish Atomic Energy Commission, Risoe. Research Establishment). May 1969. 23p. (CONF-690614-2). Dep.

From Meeting of the European Two-Phase Flow Group, Karlsruhe, Germany.

A burnout model for an annulus geometry based upon the Isbin-Vanderwater spray-annular flow model is evaluated. On the introduction of deposition and entrainment data from round duct measurements, the model predicts the burnout steam quality in annuli with different heat fluxes on the inner and the outer surface. (auth)

38164 (SGAE-RT-20/1969) ON THE DYNAMICS OF HEAT TRANSFER BY MEANS OF GASES THROUGH PIPES AND DUCTS. Eigner, H. D. (Oesterreische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Reaktortechnik). 1969. 14p. (In German). (CONF-690603-1). Dep.

From 4th International Federation of Automatic Control Conference, Warsaw, Poland.

Equations describing the dynamics of heat transfer through pipes and ducts by gases are derived. It is assumed that the conducting tube is insulated against heat loss or that it is a question of a coolant channel of a gas-cooled reactor where heat is conducted along the channel. (J.S.R.)

38165 EXPERIMENTAL DETERMINATION OF THE SLIP RATIO IN A VERTICAL BOILING CHANNEL, UNDER ADIABATIC CONDITIONS AT ATMOSPHERIC PRESSURE. Cimorelli, L.; Evangelisti, R. (CNEN, Rome). Int. J. Heat Mass Transfer., 12: 713-26(June 1969).

An experimental method is presented for the determination of slip ratio in a tubular channel with two-phase flow in adiabatic conditions. The method is based on the measurement of the vapour velocity by means of statistical correlation functions. An example is given of a calculation from the data obtained in a small experimental loop. (auth)

38166 DETERMINATION OF THE HEAT TRANSMISSION BETWEEN A NUCLEAR FUEL ELEMENT CAN AND A COOLANT. (to EURATOM). French Patent 1,475,819. Filed Feb. 18, 1966.

A method is described for the measurement of heat transmission between a fuel element can and a coolant. The surface of an experimental can that is opposite to the surface contacted by the coolant is provided with a coating composed of two layers, the inner layer consisting of an electrical insulating material, e.g., Al_2O_3 having a thickness of about 10 μ, and the outer layer consisting of an electrical conducting material, e.g., Ni, having an arbitrary thickness, preferably about 10 μ. In use the outer layer is heated by the passage of electrical current and the heat transfer to the coolant is measured by conventional means. (NPO)

38167 VOID FRACTION IN AN ANNULAR CHANNEL AT ATMOSPHERIC PRESSURE. Evangelisti, Roberto; Lupoli, Paolo (CNEN, Rome). Int. J. Heat Mass Transfer., 12: 699-711(June 1969).

The application of the γ-absorption method to measurement of vapor volumetric fraction during forced convection boiling in a small annular channel is discussed. Experimental results are presented and compared with existing theoretical models in the subcooled region. (auth) (UK)

38168 EFFECT OF AXIAL HEAT CONDUCTION ON THE THERMAL DEVELOPMENT OF A HEAT-GENERATING FLUID. Nelson, M. E. (Univ. of Virginia, Charlottesville); Rust, J. H.; Iachetta, F. A. Nucl. Sci. Eng., 37: 216-23(Aug. 1969).

An analysis was made to determine the heat transfer characteristics for steady, fully developed flow of a heat-generating fluid between isothermal parallel plates. Axial conduction is not neglected and the velocity profile is assumed to be nonuniform in the transverse direction. The results indicate that axial conduction is a low Peclet-number thermal-entrance region effect and increases or decreases Nusselt numbers depending on the heat-source strength and the boundary conditions. (auth)

38169 USTOICHIVOST' KIPYASHCHIKH APPARATOV. (Stability of Boiling Apparatus). Morozov, I. I.; Gerliga, V. A. Moscow, Atomizdat, 1969. 280p.

Theoretical aspects of stability in thermo-technical processes in boiling devices in nuclear installations are analyzed. Methods are given for calculating the stability and transition processes. Special problems on one-dimensional flow of subcooled fluids, high frequency pulsations in boiling channels and programming problems on dynamics of boiling apparatus are discussed. 87 references. (R.V.J.)

38170 HEAT TRANSFER TO FULLY DEVELOPED TURBULENT FLOW IN A CIRCULAR TUBE WITH A NONSTEADY CIRCUMFERENTIAL HEAT FLUX. Miyasugi, Takeshi; Akimoto, Masayuki (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 90, 51-65(Mar. 1969).

Forced convection heat transfer is considered for turbulent flow in a circular tube whose circumferential heat flux varies arbitrarily with time under the condition that the flow is steady and fully developed. The case analyzed first is that of a step change in circumferential heat flux, and numerical solutions are obtained by finite-difference approximation. These numerical results are used to compute the heat transfer coefficient to vary with time and position in accordance with the energy conservation principle, and comparison is made between the unsteady heat-transfer results of this computation and those obtained using steady-state heat-transfer coefficients. The analysis is then extended to include any prescribed variation of circumferential heat flux with time. (auth) (NSA of Japan)

38171 HEAT TRANSFER IN TIGHTLY-PACKED FUEL ROD BUNDLES WITH LIQUID METAL COOLING. Nijsing, Reinier; Eifler, Walter (Joint Research Centre, Ispra, Italy). Euro-Spectra, 8: 50-1(June 1969).

A method of calculating heat transfer is described based on data obtained using a hydrodynamic program involving water under ambient conditions to determine the coolant velocity. This information together with data on the measured thermal conductivity of the rod materials is used as input for the heat transfer analysis. (J.R.D.)

Isotope Technology

Refer also to abstracts 37976, 38068, 38073, 38148, 38207, 38216, and 38264.

38172 (AERE-R-6091) A GAS TARGET SYSTEM FOR CONTINUOUS PRODUCTION AND RAPID ISOLATION OF THE SHORT-LIVED RADIOISOTOPE ^{35}Ar. Wick, G. L. (Atomic Energy Research Establishment, Harwell (England)). May 1969. 20p. Dep. CFSTI. UK 2s. 6d.

A detailed description is given of the design and operation of a continuous flow gas target system used for the production and isolation of ^{35}Ar. Vaporous CCl_4 was used as the target material for the reaction $^{35}Cl(p,n)^{35}Ar$. In subsequent stages the ^{35}Ar was separated from the carrier gas CCl_4 and transported to a shielded region where the decay $^{35}Ar(\beta^+)^{35}Cl$ was studied. (auth)

38173 (BNWL-1085) PACIFIC NORTHWEST LABORATORY DIVISION OF ISOTOPE DEVELOPMENT PROGRAMS, QUARTERLY REPORT, FEBRUARY–APRIL 1969. Sheely, W. F. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 61p. Dep. CFSTI.

ACOUSTIC EMISSION TESTING—development of advanced methods of, for welds
CALIFORNIUM ISOTOPES CF-252—use as neutron source in radiography
CIRCULATORY SYSTEM—support device for, radiation dose from radioisotope-fueled
COBALT ISOTOPES Co-60—heat sources of, nondestructive testing of capsule welds for
FUEL CAPSULES—fabrication and testing of promethium-147 heat source
HASTELLOY X—properties for use as promethium-147 heat source capsules
HAYNES 25 ALLOY—properties for use as promethium-147 heat source capsules
HEAT SOURCES—development and testing of promethium-147
NEODYMIUM OXIDES—crystal structure of
PALLADIUM ISOTOPES Pd-107—content in reactor-irradiated fuel
PROMETHIUM—preparation and properties of
PROMETHIUM ISOTOPES Pm-147—use as heat source in guidance system of Advanced Manned Strategic Aircraft
PROMETHIUM OXIDES—Pm_2O_3–Sm_2O_3, phase studies
—crystal structure of
—properties of liquid, radiographic system for measurement of
—fabrication of promethium-147-enriched, methods for
RADIOGRAPHY, INDUSTRIAL—development of neutron, using californium-252
RADIOISOTOPES—production in power reactors, economic evaluation of
REACTOR FUELS—rhodium-102 content of irradiated
—palladium-107 content of irradiated
REACTORS, POWER—radioisotope production in, economic evaluation of
REFRACTORY MATERIALS—properties for use as promethium-147 heat source capsules
RHODIUM ISOTOPES Rh-102—content in reactor-irradiated fuel
SAMARIUM OXIDES—Pm_2O_3–Sm_2O_3, phase studies
—crystal structure of
STRONTIUM SILICATES—physical properties of radiation sources of, nondestructive methods for determination of
ULTRASONIC TESTING—development for radioisotope heat source capsule materials
WELDS—testing of, acoustic emission method for (R.C.K.)

38174 (CEA-CONF-1238) VALIDITY OF RADIOACTIVE STANDARDS. le Gallic, Yves (Commissariat a l'Energie Atomique, Saclay (France). [Centre d'Etudes Nucleaires]). [nd]. 13p. (In French). (CONF-681101-17). Dep.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

The validity of primary and secondary radioactive standards is considered, and the factors affecting their validity are discussed. The validity of standards depends on exact preparation of primary standards in each metrology laboratory, concerted international effort to determine the fundamental constants (decay scheme, half-lives, etc.), and an international agreement for the normalization of the expression of results and errors. (J.S.R.)

38175 (EUR-4236) PILOT INSTALLATION FOR THE SEPARATION OF ^{137}Cs BY CENTRIFUGATION. Fradin, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 28, 1968. 126p. (In French). Dep.

A pilot installation was set up to establish the industrial value of the process developed and tested in the laboratory for the separation of cesium-137. Previously a static apparatus, which is not suitable for an installation intended for continuous operation, was used. Using the pilot unit it was possible to carry out complete chemical processing cycles which can be extrapolated to a large apparatus. Technological information was also obtained on the value both of the chemical apparatus and on that of the controls. A description of the shielded cells and the mechanical and chemical apparatus with all the protective and safety devices as well as the measurement, operation, adjustment, and control procedures is given. (auth)

38176 (K-OA-1552(Rev.1)) SEPARATION OF KRYPTON FROM AIR BY MEANS OF A PERMSELECTIVE MEMBRANE. Blumkin, S. (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1969]. Contract W-7405-eng-26. 14p. Dep. CFSTI.

It is estimated that a capital investment of $1,100,000 is required to build a cascade, which has the dimethyl silicone membrane as the separating element and which can deplete the krypton in a reactor containment vessel after an accidental release of fission product gases by a factor of 100 in one week, during which 50,000 scf of removed krypton and associated gases are collected for storage. If the depletion time is extended to a month, the cascade cost is reduced to $300,000. The effect of doubling the quantity of hot gas to be stored has a negligible effect on cascade cost. If all but about 5% of the oxygen in the containment vessel is removed by chemical or other means, before the containment vessel air is fed to the membrane cascade, the estimated capital cost is reduced slightly to about $1,000,000. (auth)

38177 (K-OA-1622(Rev.1)) PERMSELECTIVE MEMBRANE CASCADES FOR THE SEPARATION OF XENON AND KRYPTON FROM ARGON. Blumkin, S. (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1969]. Contract W-7405-eng-26. 13p. Dep. CFSTI.

It is estimated that a capital investment of $366,000 is required to construct a dimethyl silicone membrane cascade designed to process 10 scfm of radioactive mixture argon containing fission product xenon and krypton present at the level of 567 curies per scf. The stream depleted in xenon and krypton from this cascade has an activity less than 0.03 curies per scf and can be withdrawn at the rate of 9.98 scfm. Thus, the gas concentrated in fission products can be collected for storage at the rate of 0.02 scfm. For larger collection rates, cascade size and cost can be reduced: if the gas storage rates are 0.1 and 1.0 scfm the cascade capital cost estimates are $342,000 and $289,000, respectively. These results should be regarded as preliminary and no more than a presentation of the potential applicability of the membrane to the desired separations. Assumptions such as those associated with cascade designs have appreciable uncertainties in them. The membrane cost used is a projection by the manufacturer to some future mass production level. (auth)

38178 (MMM-3824-34) SNAP-23A PROGRAM, PHASE I. THERMOELECTRIC CONVERTER DEVELOPMENT PROGRAM. Quarterly Report No. 9, January 1–March 31, 1969. (Minnesota Mining and Mfg. Co., St. Paul. Electrical Products Group). Apr. 30, 1969. Contract AT(30-1)-3824. 163p. Dep. CFSTI.

The design base criteria selected to control design selections and trade-offs for the prototype mockup converter (PMC-2) were established on the premise that PMC-2 would be integrated into a fueled prototype mockup system. Under the consideration that a fueled system would be representative of an advanced operational unit, design emphasis was directed toward operational environmental requirements. Areas of design investigation were conducted on effects of ambient temperature increase on converter performance, effects of potential T/E degradation upon converter performance, and enclosure structure suitability to operational environment. The effects of ambient temperature increase and degradation analysis produced a change in converter operating temperature. Thermoelectric couple design was only changed in respective segment lengths while overall couple length remained the same; the number of couples was increased to 280. The suitability of the structure to an operational environment was improved by selection of Inconel 625 for superior corrosion resistance in a salt environment, relocation of exterior instrumentation headers to an interior header ring under the converter top cover, removal of upper bolt flange and incorporation of a welded upper rain cover extension, redesign of lower bolted flange interface with lower

rain cover, relocation and redesign of the power header and associated transition terminal, redesign of converter internal pinning structures to compensate for the change in thermal properties of the outer case material (Inconel 625 vs. 304 stainless steel as formerly used), relocation and redesign of the gas fill port, removal of the pressure gage, redesign of top cone, and redesign of bottom cover. (J.R.D.)

38179 (N-69-23368) ELECTRICAL CONTROL PACKAGE FOR BRAYTON POWER CONVERSION SYSTEM. Final Report. (Hayes International Corp., Huntsville, Ala. Missile and Space Support Div.). Jan. 1969. Contract NAS3-11784. 44p. (NASA-CR-72479). CFSTI.

The Brayton power conversion system (PCS) has applicability for solar, radioisotopes, and nuclear space power systems in the net output power range of 2.25 to 10.5 kWe at 1200 Hertz. The Brayton PCS is designed to operate unattended in space for five years. The Brayton rotating unit (BRU) for the Brayton PCS is a constant speed single shaft unit. The 1200 Hertz alternator section of the shaft is supported by gas bearings with a compressor overhung on one end of the single shaft and a turbine overhung on the other end. A mixture of gases is used as the working fluid to convert the heat energy input into electrical energy as the output of the alternator. The electrical control package contains the circuitry necessary to maintain the alternator output within finite limits of voltage and frequency and also functions as the power distribution center for the alternator output power. The circuitry consists of the alternator series field power supply, the voltage regulator for controlling the shunt field supply, and the three channel speed control. (auth) (STAR)

38180 (NP-17883) THE PRODUCTION OF RADIOISOTOPE SOURCES IN AUSTRALIA. Engelbert, U. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). [1969]. 27p. Dep.

Facilities and methods for the production of radioisotope sources in Australia are described. The design of irradiation facilities and the selection and properties of capsule materials for maximum neutron economy are discussed. The irradiation of cobalt-60 and iridium-192 for the fabrication of high specific activity sources is discussed. Availability of the sources, radioactivity measurements, and future production trends is summarized. (R.C.K.)

38181 (ORNL-4427) SOURCE APPLICATION GUIDE BASED ON THE ORNL SOURCE CAPSULE CLASSIFICATION SYSTEM. Niemeyer, R. G. (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 62p. Dep. CFSTI.

A system has been developed for classifying a wide variety of radioactive source capsules according to their containment integrity and their intended use and use environment. The system consists of a Source Application Guide and of a revised Source Capsule Classification System. The Application Guide establishes a suggested capsule classification by evaluating the key containment factors involved in source usage and relating them to the containment reliability of the capsule as expressed by the Classification System. The test procedures required with the Classification System and a few examples of how to use the Application Guide are appended. (auth)

38182 (ORNL-IIC-22(Pt.1)) SELECTED ABSTRACTS OF WORLD LITERATURE ON PRODUCTION AND INDUSTRIAL USES OF RADIOISOTOPES (FROM NSA, JANUARY-MARCH 1969). Gerrard, Martha; Baker, P. S. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 57p. Dep. CFSTI.

Approximately 500 abstracts of domestic and foreign publications on production and use of radioisotopes and radiation, selected from the January to March 1969 issues of Nuclear Science Abstracts, are presented. (auth)

38183 (ORNL-IIC-24) ISOTOPES INFORMATION CENTER KEYWORD THESAURUS. Lafferty, Robert H. Jr. (ed.) (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 98p. Dep. CFSTI.

The thesaurus of keywords used by the Isotopes Information Center of Oak Ridge National Laboratory is presented in both hierarchical and alphabetical arrangement, together with a cross-reference list and some instructions on how to index. (auth)

38184 (PEL-189) A READING LIST ON THE APPLICATIONS OF ISOTOPES IN INDUSTRY (MECHANICAL ENGINEERING). Snyman, G. C.; van Rooyen, Marietha (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Apr. 1969. 33p. Dep.

References (187) on the uses of radioisotopes in mechanical engineering are given to books, conferences, reports, and journals published from 1956 through 1968. A subject index is included. (G.M.C.)

38185 COMPUTER EVALUATION OF TRACER INVESTIGATIONS ON SYSTEMS, WHEN OUTPUT FLOW IS RECIRCULATED TO THE INLET. Sjoestedt, Tor (Swedish Cellulose Co., Sundsvall). Acta Polytech. Scand., Math. Comput. Mach. Ser., No. 17, 1-19(1969).

Radioactive tracers are often used for determination of the residence time distribution for material flow through a system. When a fraction or all of the output flow is recirculated to the inlet, the residence time distribution must be computed from the recorded concentration-vs.-time curve at the outlet. The required equation for doing this is derived, and numerical calculations based on the derived formula are discussed and illustrated. Equations are also derived which permit calculation of the moments of the residence time distribution from parameters taken from the recorded tracer concentration. (Sweden)

38186 APPLICATION OF TRACER AND IRRADIATION TECHNIQUES IN SOME LEADING EUROPEAN INDUSTRIAL COUNTRIES. Foeldiak, G. (Institut fuer Isotopes, Budapest). Isotopenpraxis, 5: 128-34(Apr. 1969). (In German).

Results of a study tour into some countries organized by the International Atomic Energy Agency are presented. Problems of isotope and irradiation techniques were studied. (auth)

38187 INVESTIGATION OF A ONCE-THROUGH DUAL-TEMPERATURE LABORATORY PLANT FOR ISOTOPE SEPARATION. Marginean, P.; Mercea, I.; Mercea, V.; Olariu, A. (Institut fuer Atomphysik, Cluj). Isotopenpraxis, 5: 157-60(Apr. 1969). (In German).

A once-through dual-temperature system is studied. The concentrations of the isotopes in the gas and in the liquid are shown to be linearly related to each other. A technique is given for experimentally determining the real parameters of the column. (auth)

38188 EXPERIMENTAL VERIFICATION OF THE THERMAL DIFFUSION COLUMN THEORY AS APPLIED TO THE SEPARATION OF ISOTOPICALLY SUBSTITUTED NITROGEN AND ISOTOPICALLY SUBSTITUTED OXYGEN. Rutherford, W. M.; Roos, W. J.; Kaminski, K. J. (Monsanto Research Corp., Miamisburg, Ohio). J. Chem. Phys., 50: 5359-65(June 15, 1969).

By means of techniques previously developed, column transport coefficients were measured for the $^{14}N^{14}N-^{14}N^{15}N$ and $^{16}O^{16}O-^{16}O^{18}O$ separations in a 7.32-m hot-wire thermal diffusion column at wire temperatures of 500 and 800°C. These data and several sets of column data from previous work were compared with predicted values calculated from the Jones and Furry theory with integrations based on carefully selected tables of smoothed transport properties. On the basis of measurements for nitrogen reported previously it was assumed that the isotopic thermal diffusion factors for both gases were 0.7 times the value given by the Lennard-Jones potential. Good agreement was obtained between theory and experiment. The average ratios of the measured values of the column coefficients to the corresponding predicted values were found to be unity within essentially twice the standard deviation of the experimental determinations. There were negligible differences between column coefficients calculated from tabulated transport properties and those calculated from Lennard-Jones shape factors. (auth)

38189 SELECTED MATERIALS CONCERNING FUTURE OWNERSHIP OF THE AEC'S GASEOUS DIFFUSION PLANTS, JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-FIRST CONGRESS, FIRST SESSION, JUNE 1969. Washington, D. C., Joint Committee on Atomic Energy, 1969. 502p. GPO $2.00.

A review is given on the future ownership of uranium-enrichment facilities in the U. S., the national security, competition, regulations, economic aspects, and the alternatives for ownership and operation. All phases of the integrated three-plant AEC operation are discussed. Background information on uranium enrichment and the forecast of growth of nuclear power are given. The industrial community reports in depth on the AEC staff summary report. The possibility of the transfer of the plants to private ownership involves obligations and responsibilities, enrichment services and demands, and economics. Additional plants, cost of services rendered, and foreign demands are also considered should there be private ownership. The report of a Forum Study Committee, Atomic Industrial Forum, Inc., June 1968 on the private ownership and operation of uranium enrichment facilities is given. The summary of the AEC commitments to furnish special nuclear materials to foreign nations for civilian use is presented. An AEC study on comparative cash flow to the U.S. Treasury under assumed ownership by government or private industry and an analysis of U. S. foreign fuel supply policy are also discussed. (J.C.W.)

38190 FACTORS RELATING TO THE APPLICATION OF RADIOISOTOPES TO CIRCULATORY SUPPORT SYSTEMS. Cole,

Donald W.; Mott, William E.; Sagan, Leonard A. (Atomic Energy Commission, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Aerospace Electron. Syst., AES-5: 134-41(Mar. 1969).

A feasibility study of an implantable radioisotope-powered blood pump was made. Requirements of such a system, advantages of various isotopes, and doses received by the patient are outlined. The proposed circulatory support system would consist of a blood pump located near the heart, a power supply probably located in the abdominal cavity, some form of power transmission between the energy source and the blood pump, and a control system utilizing physiological input signals to regulate the power. With radioisotope power, the supply is subdivided into a radioisotope heat source, a thermodynamic converter, and a heat sink. Power output required is in the range of 1 to 7 W. Lifetime in the range of 7 to 10 yr is required. Criteria for selecting radionuclides for implantation as heat sources emphasize radiation, half-life, and power density. High power density and a minimum of penetrating radiation help to minimize the radiation dosage, the weight, and the volume of the unit. A reasonably long half-life would minimize the frequency of surgical replacement. Plutonium-238, ^{147}Pm, and ^{171}Tm were selected as the principal candidates for implantable power sources. Assuming that an abdominal Pu source would effectively irradiate half of the marrow and other organ systems, the integrated dose would be 0.25 rem/day, or about 90 rem/yr. Over a 10-yr period of irradiation, life shortening of 30 months might be incurred. It appears that radiation is unlikely to produce significant problems due to early or late effects, either to the patient himself or to those around him. (BBB)

38191 NEUTRON EMISSION RATES AND ENERGY SPECTRA OF TWO ^{238}Pu POWER SOURCES. Anderson, M. E.; Neff, R. A. (Monsanto Research Corp., Miamisburg, Ohio). Contract AT-33-1-GEN-53. Nucl. Appl. Technol., 7: 62-66(July 1969).

Neutron emission rates and neutron spectra were determined for two ^{238}Pu power sources: SNAP 27-1, a 1482-W plutonium dioxide source for the Apollo Space Program, and HP 15-2, a 15.84-W plutonium metal source for the Artificial Heart Program. The measurements were made with a single stilbene crystal fast neutron spectrometer and a long counter. The specific neutron yields were $(2.2 \pm 0.1) \times 10^4$ n/sec per gram of ^{238}Pu for SNAP 27-1 and $(3.9 \pm 0.2) \times 10^3$ n/sec per gram of ^{238}Pu for HP 15-2. Neutrons from these sources are due to spontaneous fission of ^{238}Pu, neutron-induced fission of plutonium, and (α,n) reactions. The contributions to the two spectra due to neutrons from each of these reactions are shown. Factors for converting from neutron fluence to dose equivalent (whole body) were calculated to be $(3.34 \pm 0.11) \times 10^{-5}$ mrem per n/cm^2 for SNAP 27-1 and $(3.13 \pm 0.15) \times 10^{-5}$ mrem per n/cm^2 for HP 15-2. (auth)

38192 RADIOACTIVE CERAMIC SOURCE AND METHOD OF MANUFACTURE. Antony, G. M.; Saint-Maur, A. M. (to Commissariat a l'Energie Atomique). Canadian Patent 806,596. Feb. 18, 1969. Priority date Oct. 29, 1964, France.

A new radioactive ceramic source which can be employed as a heat source in an electrical energy generator is proposed. It is sintered strontium fluorapatite having ^{90}Sr as a base and whose formula is $[^{90}Sr_3(PO_4)_2] \cdot {}^{90}SrF_2$. The method of manufacture by either a wet or dry process is described using strontium carbonate as the starting material. (F.S.A.)

38193 APPLICATIONS OF RADIOELEMENTS IN THE CHEMICAL AND RELATED INDUSTRIES. Cornuet, R. Ind. Chim. Belge, 32: Special No., (Vol. 1), 700-8(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

Radioelements can come into play in a large number of technical problems encountered in the chemical industry. Their reasonable use thus leads frequently to elegant and often specific solutions. Their applications cover very varied fields such as: level control, density measurement, study of circuits by the aid of tracers, continuous or sample analysis, initiation of chemical reactions by radiation, etc. These diverse applications will be reviewed, and the emphasis will be placed particularly on the most recent developments concerning the use of radioactive tracers. (tr-auth)

38194 POSSIBILITIES FOR THE USE OF RADIOISOTOPES IN SPACE. Contzen, J. P. (CECLES/ELDO, Paris). Ind. Chim. Belge, 32: Special No., (Vol. 2), 48-55(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.2).

Space constitutes a potential field for important applications for radioisotopes. These applications are divided essentially into three categories: on-board production of electric energy; propulsion engines; and production of heat or radiation for auxiliary needs. Attention is directed to the first two types of applications which undoubtedly will offer the most important results. The choice of the appropriate radioelement constitutes an essential element for the development of generators and radioisotopic propellants. This choice depends on numerous considerations among which are three principal criteria for selection: characteristics of the radioisotope in relation to the application; availability and cost; and security. An analysis carried out on the basis of these criteria furnishes the following criteria: for applications of short duration, ^{210}Po, and in a lesser degree, ^{170}Tm and ^{242}Cm; for applications of long duration, ^{227}Ac, ^{238}Pu, ^{90}Sr, and to a lesser degree, ^{147}Pm, ^{232}U–^{228}Th. An examination of the situation in Europe reveals the potentials required for the production in a reasonable time of adequate quantities of the radioisotopes mentioned and for putting into use the systems using these radioisotopes. The use of radioisotopes in space depends essentially on the demand, that is to say the definition of the missions that will be entrusted to them. (tr-auth)

38195 USE OF RADIOACTIVE TRACERS IN THE NON-FERROUS INDUSTRY. Andre, J.; Masson, N. Ind. Chim. Belge, 32: Special No., (Vol. 2), 330-4(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.2).

The use of radioactive tracers is envisaged especially for accomplishing chemical analyses for traces in extremely pure products and likewise for the study of the behavior of various elements during the course of processes of fabrication. (tr-auth)

38196 CONTRIBUTION OF RADIOISOTOPES TO THE AUTOMATION OF INDUSTRIAL CHEMICAL PROCESSES. Van Gansberghe, J. P. Ind. Chim. Belge, 32: Special No., (Vol. 2), 45-7 (1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.2).

Automation is defined by its purposes and by the means used, thus, the automation of any process whatever implies the previous knowledge of the way in which a circuit or an engine reacts to simple variations or complexes of conditions of function. The reaction of the circuit or of the engine is translated by a function analogous to an electronic transfer function. It can generally be deduced from the results obtained by a test carried out by means of radioactive tracers injected into the circuit either continuously or, more often, in an instantaneous manner. In order to accomplish the automation of a process, it is then necessary to transmit to the regulatory circuits various information translating the physical magnitudes and eventually measured chemicals downstream in the circuit. Many of these values, such as densities, levels, water contents, chemical compositions, etc., can be measured advantageously by a continuous method by means of standards based on the use of radioisotopes. (tr-auth)

38197 ENRICHED-URANIUM PRODUCTION PLANNING. Hatch, D. E.; Levin, S. A. (Union Carbide Corp., Oak Ridge, Tenn.). Nucl. Appl. Technol., 7: 44-54(July 1969).

The economics of enriched uranium production in USAEC facilities was analyzed and the equations of an optimizing economic model of the enriched uranium industry developed. The objective function that is minimized by the model is the present value of the combined controllable costs of the USAEC and of the users of enriched uranium. The economic system considered is thus unusually comprehensive and the optimization problem correspondingly complex. A basic consideration in developing the optimum operating strategy is that the existing AEC investment in diffusion plant and feed stockpiles may be used to preproduce economically some of the future requirements for enriched uranium. The model was used extensively in USAEC enriched uranium production planning. (auth)

38198 UNCONTROLLED NUCLEAR DECAY PROPULSION AND/OR POWER SYSTEMS. Romero, Jacob B. (to Boeing Co.). U. S. Patent 3,447,321. June 3, 1969. Filed Nov. 15, 1965.

A method and apparatus are disclosed for obtaining propulsion and/or power on an intermittent basis from an uncontrolled nuclear heat source such as a radioisotope. A heat containment vessel is interposed between the heat source and the ambient surroundings thereof, to absorb at least a portion of the heat from the source therein. Alternately, the thermal energy of the absorbed heat is converted into another form of energy appearing as propulsion and/or power, and the rate of heat flow to the ambient surroundings from at least one of the heat sources and the vessel, is increased so as to maintain a tolerable temperature in the vessel. The heat source and the vessel may be moved in relation to one another so as to increase the rate of heat flow from the source to

the ambient surroundings; as, for example, by altering the dimensional characteristics of the heat source so as to increase the rate of heat flow therefrom. Or, the heat may be conveyed from the vessel to increase the rate of heat outflow. (Offic. Gaz.)

38199 APPLICATION AND RESULTS OF RADIOCHEMICAL METHODS OF INVESTIGATION. Spang, Arnold (Siemens Aktiengesellschaft, Erlangen, Ger.). Siemens Rev., 36: 207-13(June 1969).

Possible applications of radioisotopes are reviewed. A description is given of isotopic tracer methods and of the chief radiochemical methods of analysis. The capability of these methods—which are being used on an ever increasing scale, particularly in view of their sensitivity—is demonstrated by the results obtained from various fields of application. (auth)

38200 INTEGRATION OF LARGE POWER SYSTEMS INTO MANNED SPACE STATIONS. Murray, William E.; Gervais, Robert L. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Aerospace Electron Syst., AES-5: 170-84(Mar. 1969).

The design of radioisotope- and reactor-powered, as well as other, sources for electrical systems for manned space stations is discussed with regard to forecasts of space-station power requirements, candidate space-station power systems, critical space-station power-system integration factors, a rationale for power-system selection and integration, and major electrical system tradeoff considerations. Comparisons between systems are based on recently defined space-station models for 90-day to 5-yr mission durations in the 1970's, with 4- to 9-man crews. Power systems encompass power levels from 3 to 50 kWe and include solar cell/battery, fuel cell, hybrid fuel cell/solar cell, radioisotope, and nuclear reactor systems. Thermoelectric, Brayton cycle, organic Rankine, and liquid-metal Rankine power conversion systems are considered for the nuclear sources. A nuclear reactor power system is the sole primary power candidate for power level requirements above 15 kWe. However, reactor power systems are at a disadvantage because an eventual reactor shutdown or replacement may be required. When this occurs, an emergency or standby power system becomes mandatory. A standby system must exhibit nearly 1.0 reliability. A radioisotope system with sufficient life-extension redundancy is the sole candidate. A radioisotope system as the standby system could perform many other functions. Safety aspects of nuclear powered systems are briefly considered. (BBB)

38201 ISOTOPIC ELECTRIC GENERATOR USING THERMOELECTRIC ELEMENTS. Freund, Jean-Pierre; Stoll, Roger (to Societe Nationale d'Etude et de Construction de Moteurs d'Aviation). British Patent 1,160,359. Aug. 6, 1969. Priority date Apr. 24, 1967, France.

An electric generator is described which comprises an outer housing and an inner metallic housing constituting a cold source, the inner housing incorporating a thermopile pressed against a support plug, forming part of the inner housing, by a thrust rod formed of heat-insulating material. Springs which bear on the inner housing and on the thrust rod to urge it towards the thermopile. A radioactive isotope heat source is interposed between the thermopile and the thrust rod, and a packing of thermally and electrically insulating material is included to separate the thermopile and the heat source container from the inner housing. The heat source container is designed such that, together with the packing, the main outlet for heat from the heat source is towards the thermopile. (J.R.D.)

38202 THERMAL CONTROL AND POWER FLATTENING FOR RADIOISOTOPIC THERMODYNAMIC POWER SYSTEM. Bienert, Walter Bruno; Levedahl, William John; Streb, Alan Joseph (to Martin-Marietta Corp.). British Patent 1,160,568. Aug. 6, 1969. Filed Nov. 21, 1966.

An improved radioisotope powered thermodynamic system is described which incorporates a heat pipe for rejection of excess heat. The rejection of excess heat may be readily varied over the life of the radioisotopic fuel using a method which involves no mechanically moving parts. The amount of heat transferred between the ends of the heat pipe is determined by the rate of movement of the working fluid, which moves as a gas through the void and as a liquid, by capillary action through the pipe lining. (J.R.D.)

38203 BETA-EMITTING RADIOISOTOPE SOURCE SEALED ONTO THE SURFACE OF AN INERT CARRIER. Sporek, Karel Frantisek (to Owens-Illinois, Inc.). U. S. Patent 3,453,196. Filed Nov. 18, 1963.

A beta-emitting radiation source produced by fusing or coating a mixture of glass and a beta-emitting isotope onto the surface of an inert shaped carrier to provide a highly efficient source of high energy radiation in high concentration at the surface in contact with the reaction medium. (Offic. Gaz.)

38204 USE OF IONIZING RADIATIONS IN INDUSTRY. Guyenot, E. Arch. Mal. Prof. Med. Trav. Secur. Sociale, 28: 89-92(Jan.-Feb. 1967). (In French).

The primary French industry using ionizing radiations is the C.E.A. and its contractors. Other primary users of radiation and the radiation sources used by them are indicated. The radiation protection services instituted are summarized. (J.S.R.)

38205 AN IMPLANTABLE NUCLEAR FUEL CAPSULE FOR AN ARTIFICIAL HEART. Norman, J. C.; Covelli, Victor H.; Bernhard, William F.; Spira, Jacob (Harvard Medical School, Boston. Boston City Hospital. Thermo Electron Engineering Corp., Waltham, Mass. Children's Hospital Medical Center, Boston). Trans. Amer. Soc. Artif. Intern. Organs, 14: 204-9(1968).

Feasibility studies have focused attention on the combination of an implantable radioisotope heat source and Rankine cycle steam engine. These considerations raise the problems of precise power requirements, dissipation of additional endogenous heat, and suitable methods of radiation shielding. Further analytical results point out the desirability of incorporating a thermal energy storage capacity into an overall system to handle peak power requirements. Experimental studies in dogs have evolved a model for the electrical simulation of additional endogenous heat. These studies have been extended to the development of an experimental model for the internal induction of additional intravascular heat of nuclear origin. Current and projected methods permit studies of the long-term (>6 months) effects of intracorporeal heat and irradiation at levels approaching and equivalent to those required by circulatory-assist devices. (auth)

Materials Testing

Refer also to abstracts 38135, 38174, 38184, 38195, 38294, 38362, 38372, 38919, 38921, 39046, 39047, and 39859.

38206 (AERE-Trans-1111) NEUTRON RADIOGRAPHY. Peter, O. Translated by C. R. Brightmore (Atomic Energy Research Establishment, Harwell, Eng.), from Z. Naturforsch., 1: 557-9(1946). 3p. Dep. CFSTI. UK 1s. 9d.

A description is given of the taking of some slow-neutron radiographs. In order to produce an image on film a "radiation converter" was used. Because of the larger radiation source used, the images did not possess the sharpness of γ-radiographs, but make new applications possible. (auth)

38207 (BNWL-1038) NONDESTRUCTIVE TESTING OF ISOTOPE CONTAINMENT CAPSULES: SNAP-21 FINAL REPORT. Steffens, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 45p. Dep. CFSTI.

Because of the toxic and radioactive core material contained in the SNAP-21 isotope capsules, it is imperative that the container integrity be assured through a reliable quality control program. Remotely implementable ultrasonic weld inspection techniques and equipment were developed to provide nondestructive test quality assurance for the SNAP-21 closure welds. The SNAP-21 weld inspection test, when implemented with the UT-40 ultrasonic test station, automatically detects weld anomalies such as porosity, laminar voids, and unfused joint interfaces. The ultrasonic anomaly indications are recorded with an X-Y mapping technique which displays circumferential and axial anomaly locations in addition to anomaly axial length. The anomaly indications are interpreted through comparison with indications observed from 0.012 to 0.070 in. diameter standard reference surfaces. The test is based upon ultrasonic signals obtained by the helical scanning of the weld volume with an ultrasonic beam aligned normally incident on the capsule side. Both normally occurring and special case ultrasonic signals and their relationship to the weld characteristics are discussed. Alignment of the ultrasonic beam up to 3° from normal in the axial plane and signal wave shaping techniques facilitate weld inspection when abnormal weld characteristics are encountered. The successful remote establishment of the four closure welds' integrity on two fueled SNAP-21 capsules provided final test certification. (auth)

38208 (BNWL-1058, pp 7.1-14) NONDESTRUCTIVE TESTING. Dau, G. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Construction of an eddy-current multiparameter tester which will provide ten operating frequencies at 1.95 kHz to 1 MHz capable of 20 parameter separation is reported. Installation of

a laboratory pulsed laser system operated by ruby or neodynium rods was completed. Tests of the rods are in progress. Development of a thermal transducer for nondestructive testing of nuclear materials is reported. Initial tests of the transducer were evaluated indicating its feasibility after further development. Efforts to classify flaws in glass by the spectra of reflected ultrasonic pulses were continued during the quarter. Flaw identification by this method appears feasible. Development of tests based on attenuation of homogeneous sound waves is described. (J.R.D.)

38209 (EUR-4237) NONDESTRUCTIVE TESTING OF FUEL ELEMENTS IN PEBBLE-BED REACTORS. Rausch, W. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Mannheim (West Germany)). Sept. 9, 1968. 38p. (In French and English). (CONF-680606-15; THTR-73). Dep.

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France.

The core of high-temperature reactors as first developed by Brown Boveri/Krupp does not consist of prismatic fuel elements as in most other reactors, instead it is made up of a pebble-bed of spherical mobile fuel elements. During operation these elements are continuously circulated. Fuel elements, with optimum burnup or defects, are discharged and replaced by new elements. All other elements are fed back to different regions of the core according to their neutron-physical characteristics. The fuel handling facility is provided with several installations for testing the mechanical and nuclear properties of the elements. Four special methods are presented for the determination of geometric integrity, mass, Young's modulus, gamma-activity, burnup, and overall neutron-physical behavior. (auth)

38210 (ORNL-tr-2140) ON THE BEHAVIOR OF PARTIALLY PERMEABLE INTERFACES DURING NON-DESTRUCTIVE MATERIAL TESTING BY ULTRASONICS. PART II. MODEL TESTS AND APPLICATION POSSIBILITIES. Mundry, Eberhard. Translated for Oak Ridge National Lab., Tenn., from Materialpruefung, 9: 120-30(1967). 31p. Dep. CFSTI.

Tests are described on a model with a partially permeable glass/mercury interface. The reflection factors determined from the measured reflectograms, studies concerning the phase of the echoes, and the formation of interference echo sequences have fully proved the theory. Applicability of this theory in non-destructive testing of composite materials and sheets, in evaluating reflectograms of single defects, and in measuring the phase shift for direct probe-to-specimen contact is discussed. (auth)

38211 RADIOGRAPHY WITH LOW INTENSITY NEUTRON BEAMS: SOME RECIPROCITY FAILURE CHARACTERISTICS OF FILMS USED WITH LIGHT-EMITTING INTENSIFYING SCREENS. Hawkesworth, M. R. (Univ. of Birmingham, Eng.). J. Phys., E (London), 2: 673-8(Aug. 1969).

The reciprocity law failure characteristics of photographic films used with light emitting screens (NE421 and NE905) were studied to facilitate the estimation of exposure times at low neutron beam intensities. Observations were made in the intensity range from 10^2 to 10^5 neutrons per cm^2s—the limits of practical interest for light emitting screens. In this region it was expected that only low intensity reciprocity failure would be observed and this was confirmed. The reciprocity characteristics observed are shown as plots of exposure time t as a function of beam intensity ϕ, which is thought to be the most useful presentation for radiographic use and enabled the degree of applicability of the Schwarzschild relation (ϕt^p = constant) to be ascertained. The relation was found to fit the observations well, with a constant value for the index p which is characteristic of the film and close to the values found in photographic work. (auth) (UK)

38212 CHARACTERISTICS OF LEAD FOIL SCREENS IN LINAC X-RAY RADIOGRAPHY. I. Hiraoka, Eiichi; Furuta, Junichiro; Ohnishi, Tokuhiro; Tsujii, Yukio. Annu. Rep. Radiat. Center Osaka Prefect., 9: 60-3(1968).

The finest condition on fault sensitivity at various x-ray energies is reported for radiography using the ORC Linac. The measurements are made using the lead foils of several thickness and the penetrameter of wire and Bacillus type. (auth)

38213 IN-MOTION RADIOGRAPHY. Hopkins, W. K. Precis. Metal Molding, 26: No. 8, 40-4(Aug. 1968).

All defects that can be detected by stationary radiography can be detected as well, and often better, by in-motion radiography (IMR). In IMR, the x-ray unit and the work being inspected are in constant relative motion with respect to each other. A continuous radiograph that can be almost any desired length or width, limited mainly by the size of the film, is produced. Repeated passes may be made over the same area to obtain the desired density in a finished radiograph. Almost any x-ray unit can be adapted to this technique, with less radiation hazard than in a stationary setup. The method was developed to examine large sections of adhesive-bonded Al and stainless steel honeycomb structures. Excellent radiographs have been made of thick to thin contoured honeycombs, of welds in large tanks, of investment castings (inspection for porosity), and of assembled aircraft extrusions (inspection for corrosion). (Metals Abstr.)

38214 THE DEVELOPMENT OF NEUTRON RADIOGRAPHY IN THE UKAEA AT DOUNREAY. Spowart, A. R. (Dounreay Experimental Reactor Establishment, Caithness, Scotland). Mater. Eval., 27: 159-64(July 1969).

Transfer and direct techniques of neutron radiography are described. The relative merits as compared to conventional x and γ radiography are also discussed. Furthermore, the characteristics of the thermal neutron reactor, the various collimators and the calculations for use in determining a practical threshold of thermal neutron flux for radiography are also discussed. Based on these calculations, the sealed tube neutron generators are then described in greater detail. Emphasis is given to a novel approach on boosting the flux in such a generator. Ultimately the specific application at Dounreay with regard to the neutron radiography of enriched uranium and plutonium is described. (auth)

38215 BOUNDARY CONDITIONS ALONG THE LINE OF INTERSECTION OF TWO STATICALLY LOADED SHELLS. Mai, W. (VEB Kernkraftwerksbau, Berlin). Kernenergie, 12: 92-7 (Mar. 1969). (In German).

The boundary conditions which must be fulfilled along the line of intersection of two statically loaded shells, were established. (auth)

38216 MEASUREMENT OF THE ACTIVITY OF ^{60}Co IN PIG IRON BY MEASUREMENT OF γ RADIATION. Sommerkron, Gernot. Arch. Eisenhuettenw., 39: 959-62(Dec. 1968). (In German).

The use of ^{60}Co γ radiation to evaluate wear in blast furnace linings by measurement of activity in pig iron samples was studied. In contrast to similar measurements with β emitters this procedure involved no self absorption, larger samples could be used, and the accuracy of the measurements was improved. Procedures for calibration of the measurement equipment with ^{40}K were developed in great detail. The absolute ^{60}Co activity in the pig iron samples was correlated with the ^{40}K measurements. In samples that contained more than 0.1 mCi/g of ^{60}Co the maximum activities of the samples were about 8.5% higher than those measured at the sample surface. These differences may have been due to statistical differences in background counts. The ^{60}Co found in the samples measured ranged from 0.62 to 0.683 nCi/g, with an error of 10%. As compared with the legal limit of 2 nCi/g, the measured values were far below this value, even when the measurement errors were taken into account. (BBB)

38217 A METHOD OF NON-DESTRUCTIVE TESTING AND MASKING LIQUIDS FOR SUCH TESTING. Ichikawa, Wataru (to Asahi Glass Co. Ltd.). British Patent 1,150,193. Apr. 30, 1969. Filed Mar. 31, 1967.

Reference is made to methods of nondestructive testing which make use of radiation, for example in the testing of metallic materials for interior defects and the inspection of welds. When such methods are applied to objects of complicated configuration, having for example uneven parts or bends, fogging of film occurs due to scattered radiation, leading to blurred images, particularly at the edges of the test object. A method is described for overcoming this difficulty. The test material is surrounded by an aqueous metal iodide solution (Zn, Cd, alkali metal, alkaline earth metal), this solution having a masking effect for the radiation approximately the same as that of the material being tested. The scattered radiation is thereby masked and the whole of the test material and its surroundings can be subjected to irradiation under substantially uniform conditions, giving sharp images of the test material, with good contrast. The test material may be immersed in the masking liquid, or the latter may be contained in deformable liquid-impermeable sacks surrounding the test object. The iodide solution may also contain a reducing agent, such as a thiosulfate or hydroxylamine, to prevent the production of strong coloration or turbidity in the solution. Examples of application of the method are given. (UK)

38218 METHOD OF AND APPARATUS FOR THE CONTINUOUS, CONTACTLESS, AND NON-DESTRUCTIVE DIAMETER INSPECTION OF ELONGATED STRUCTURES. Knorr, Juergen Joachim Hubertus; Loeffler, Helmut Arthur; Vogel, Wolfgang Otto (to VEB Kabelwerk Oberspree (KWO). British Patent 1,154,415. June 11, 1969. Filed July 19, 1967.

A diameter inspection method using radioactive sources is

described. An annular source surrounds a zone through which the elongated structure is movable, or the source may be rotated around this zone, and the attenuated radiation passing through the structure is incident on an annular ionization chamber surrounding the zone, the ionization current produced being registered to indicate diameter of the structure. The ionization chamber may have a radiation entry window provided with a mask. (UK)

38219 REVIEW OF RADIOGRAPHIC INSPECTIONS IN 1967. Senda, Tomio (Osaka Univ.). Hihakl Kensa, 17: 471-3 (Nov. 1968). (In Japanese).

The state of radiation-penetration tests is described. Revisions in the standardization by Japan Welding Society, by societies of light metals, and by non-destructive testing organizations in 1967, are given. Developments of inspection devices include the application of tube voltage wave-shapes to x-rays, stationary x-ray devices, ^{192}Ir, sealed radiation-source safety standards, exposure in x-ray penetrations, neutron-radiography, penetration for welded pipes, and fluorescent x-rays. Differentiation in penetration tests, measurable thicknesses, density measurement, sensitive agents, radiographic images, and penetration of massive steels are described. Inspection methods include the relationship between steel-weld defects, strengths against shock, fatigue, and a variety of tests on the welds of reactor pressure vessel. (NSA of Japan)

Protective Structures

Refer to abstract 38600.

Radioactive Material Handling

Refer also to abstracts 38099, 38155, and 38916.

38220 (ORNL-TM-2626) OAK RIDGE NATIONAL LABORATORY TUNGSTEN-SHIELDED CASK. Seagren, R. D. (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 38p. Dep.

A small, light-weight, tungsten-shielded shipping cask was designed, fabricated, and approved for the national and international transport of large quantities of solid and liquid nonfissile radioactive material. The design effects reduction of the weight and volume of the cask and minimizes problems previously associated with transporting casks of this type and handling them in hot cells. The shielding material selected meets the requirements of national and international regulatory groups. (auth)

38221 STATION FOR THE CONTROL OF RADIOACTIVE LIQUID WASTES AT ISPRA. de Bortoli, M.; Gaglione, P.; Gandino, C. (CCR-EURATOM, Ispra, Italy). G. Fis. Sanit. Prot. Radiaz., 12: 304-11(Oct.-Dec. 1968). (In Italian).

The station for control of the radioactive liquid wastes from the Euratom Ispra establishment is described. The station is located on the side of the Novellino brook, via which the effluents are released into the environment and comprises a concrete bed tract, with a weir and a hydrograph to allow continuous determination of the water flow. A double radioactivity control has been conceived: in order to detect eventual accidental releases a direct monitor, with alarm signal, provides instantaneous measurement of the water activity, whereas a continuous and proportional sampling device yields water samples for later and more exact qualitative and quantitative determinations. The experience gained after operation of almost one year is briefly discussed. (auth)

38222 SAMPLE TRANSFERRING APPARATUS FOR RADIOACTIVE SAMPLES. Smith, Roy F. (to Packard Instrument Co., Inc.). U. S. Patent 3,450,881. June 17, 1969. Filed Apr. 6, 1965.

In an apparatus for detecting and measuring radioactivity emanating from a sample by scintillation techniques, a sample transferring mechanism is provided which permits a sample to be inserted into, or withdrawn from, the scintillation zone. The mechanism features a light lock with gates above and below a lock area so that the sample may be transferred via the lock area into the scintillation zone. The light lock is constructed to eliminate rubbing contact of the elevator or sample container which would produce static electricity and hence spurious scintillation signals. Gates surrounding the lock area are actuated by fluid operated interlocking controls. (Offic. Gaz.)

38223 DISPOSAL OF PROCESS WASTES: LIQUIDS, SOLIDS, GASES. A Symposium Presented at the ACHEMA Meeting, 1964, Frankfurt am Main, Germany. New York, Chemical Publishing Company, Inc., 1968. 244p. $12.50. (CONF-641137).

Translated from the German by Max Wulfinghoff.

A total of fifteen papers were presented at the conference. A separate abstract was prepared for each of three papers. Papers for which no abstracts were prepared are concerned with clean environment, reclamation of effluent chemicals, waste treatment, oil contamination, protein recovery, detergents, waste gases, waste burning, sulfur trioxide, inorganic emissions, incineration, and ion exchange separation. (J.R.D.)

For abstracts of individual papers see: 38224–38226.

38224 RECLAMATION OF WASTE WATER CONTAINING RADIOACTIVE ADMIXTURES. Mende, H. pp 97-105 of Disposal of Process Wastes. New York, Chemical Publishing Co., Inc., 1968.

From Symposium on Disposal of Process Wastes, Frankfurt am Main, Germany. See CONF-641137.

Effluents containing radioactive contaminants can be treated by various decontamination processes to bring the radioactivity to a figure below the permissible maximum. The methods of dilution, settling, chemical precipitation or flocculation, and ion exchange are compared with evaporation. Various types of evaporators are discussed with respect to their suitabilities for decontamination purposes. Results of the optimalization of a forced-circulation evaporator with vapor-recompression indicate that decontamination by evaporation is often more economical than by other methods. An example is given of the effects on a cost-calculation of the costs of plant and energy. Certain precautions have to be taken for safety reasons in both design and process details. Operational results of decontamination-evaporators in various research establishments with throughputs of 200 to 1300 kg of distillate per hour demonstrate the economy and decontaminative efficacy of plants of that type. As suitable evaporators can be run economically and with little supervision, there is now a noticeable tendency toward decontamination of effluents containing long-lived isotopes by evaporation, rather than by chemical precipitation or flocculation. (auth)

38225 ENCAPSULATION OF HIGH-LEVEL NUCLEAR WASTES. Rickles, R. N. (Dorr Oliver Inc., Stamford, Conn.). pp 107-36 of Disposal of Process Wastes. New York, Chemical Publishing Co., Inc., 1968.

From Symposium on Disposal of Process Wastes, Frankfurt am Main, Germany. See CONF-641137.

The requirements for practical economic encapsulation systems for the long-term premanent storage of high-level nuclear wastes are discussed. The present status of research and development efforts in this area is reviewed. A logical application of those requirements to present development programs indicates that they do not recognize the overall requirements for safe and practical disposal of these wastes. Furthermore, these requirements indicate that certain directions should be followed in the development of optimum processes. Several new proposals for development efforts are presented together with defining technological and economic parameters. (auth)

38226 PROGRESS REPORT 1964-66. Wulfinghoff, M. pp 211-20 of Disposal of Process Wastes. New York, Chemical Publishing Co., Inc., 1968.

From Symposium on Disposal of Process Wastes, Frankfurt am Main, Germany. See CONF-641137.

Discussions of waste disposal practices and methods of improving these practices are presented. Included are discussions of solid waste, refuse disposal by compositing, and characteristics of furnaces. Properties of dusts, suspensions, sludges, and slurries are examined along with water pollution, methods of chemical recovery, and characteristics of gaseous and radioactive wastes. (J.R.D.)

38227 PROCESS FOR THE PURIFICATION OF RADIOACTIVE WASTE GASES. (to Japan Atomic Energy Research Inst.). French Patent 1,514,989. Filed Sept. 7, 1966.

A process for the purification of radioactive waste gases is described which consists of compressing the gases; subjecting the gases to a preliminary cooling in a heat exchanger; cooling the gases by expansion; passing the gases through a filter, preferably a charcoal filter, to retain the radioactive contaminants; returning the cooled and purified gases to the heat exchanger to effect the preliminary cooling of the contaminated gases, and finally; discharging the gases into the atmosphere. (NPO)

38228 PROCESS FOR PROVIDING ARTICLES WITH A DETACHABLE PROTECTIVE COATING. (to Firma Asmara-Chemie Herbert G. Scharf). French Patent 1,459,062. Filed Sept. 9, 1965.

A process is described for providing articles such as arms, trucks, and tanks with a coating protecting them against contamination with radioactive, biological, or chemical warfare materials, the coating being easily detachable from the surface of the articles, thereby entraining the contaminants possibly deposited on the surface. The process involves: covering the surface of the articles to be coated with a layer consisting of a material which facilitates the detaching of the protective coating without impairing its adherence, e.g., silicones, polyethylene-oxides and salts or esters of stearic acid; covering said layer with a second layer consisting of a salt, an alcoholate or an ester of polymannuronic acid, preferably mixed with an aqueous dispersion of a synthetic resin; and treating the coating thus obtained with an aqueous solution of a salt of a metal which forms an insoluble compound with polymannuronic acid, e.g., a salt of Ca, Al and/or Be. Preferably the compound of polymannuronic acid is mixed with a material which prevents spontaneous ion exchange, e.g., water-soluble salts of poly-, pyro- and metaphosphoric acid or condensation products of ammonia or urea with phosphoric acids. (NPO)

38229 FIELD EXPEDIENT RADIOACTIVE WASTE INCINERATOR. Tarbox, James L.; Lachapelle, David G. (to U. S. Army). U. S. Patent 3,452,690. Filed Dec. 8, 1967.

A portable incinerator for efficient and economical concentration and disposal of combustible radioactive waste is described comprising an ash pit; three tiers or sections having steel panels in each tier, the panels being bolted together and the tiers nested within each other and located over the ash pit; primary burners located in the lower tier; secondary burners located in the center tier; dampers located in the lower and middle tiers; and a spark arrester. (Offic. Gaz.)

38230 RADIOACTIVE RESIDUE INCINERATOR. (to United Kingdom Atomic Energy Authority). French Patent 1,428,149. Filed Feb. 18, 1965.

A radioactive residue incinerator is described which comprises two communicating refractory chambers each provided with combustion means, e.g., oil-burners, the first of the chambers being provided with an air inlet and a radioactive residue loading station fitted with an air lock and the second chamber being provided with an outlet fitted with gas cooling and filtering means and with a fan which maintains the interior of the chambers at a pressure below the atmospheric pressure. Preferably the second chamber is provided with a labyrinth which causes a sinuous gas flow between the first chamber and the outlet. Each chamber is provided with an ash-pan fitted with an air lock allowing removal of the ashes without danger of the ashes being dispersed into the atmosphere. (NPO)

38231 RADIOACTIVE RESIDUE INCINERATION PLANT. (to Commissariat a l'Energie Atomique). French Patent 1,406,059. Filed June 5, 1964.

A radioactive residue incineration plant is described which comprises: a radioactive residue reception and loading station provided with an air lock which is evacuated by a fan, a filter being interposed between the fan and the air lock to prevent any passage of radioactive dust from the lock; an incinerator comprising a combustion chamber and at least two post-combustion chambers disposed in series, one of them having a chimney with an expansion valve to prevent any excess pressure in the incinerator; a heat exchanger for cooling the combustion fumes and gases comprising a high temperature refractory steel heat exchanger, an expansion chamber provided with compressed air distribution, and at least one low-temperature heat exchanger; a dry dust-extracting station for the fumes, preferably comprising a centrifugal cyclone, a prefilter, and a set of final filters for successive retention of particles of diameters ranging from 10 to 0.3 μ; a fume neutralization system, preferably comprising a cooling box and a neutralization tower inside which the fumes are in contact with a NaOH solution the concentration of which is kept constant by a metering pump controlled by a pH control meter, and finally a discharge station for the ash and clinker making up the incineration waste. (NPO)

38232 FUEL CYCLE AND RADIOACTIVE WASTES. Ramdohr, H. (Gesellschaft fuer Kernforschung mbH, Leopoldshafen, Ger.). Kerntechnik, 11: 269-76(May 1969). (In German and English).

The waste quantities to be expected by 1980 are estimated; they will depend mainly on the installed capacities of new nuclear power plants. An analysis of the wastes generated in the consecutive phases of the fuel cycle shows that, expressed in terms of the activity contents, the contributions by ore production, by fuel conversion and enrichment, and by the fabrication of fuel elements, are relatively minor. The wastes generated in reactor operation are appreciable, but the predominant proportion of all wastes is generated in the course of reprocessing. The kinds of wastes generated in various phases of the fuel cycle are classified and discussed. (auth)

Vacuum Engineering

Refer also to abstracts 38368, 38369, 38942, and 38969.

38233 (FTI-231) HELIUM PUMPING BY CONDENSED LAYERS OF GAS IN THE PRESSURE INTERVAL 10^{-9} TO 10^{-13} TORR. Yuferov, V. B.; Kobzev, P. M. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1968. 9p. (In Russian). Dep.

The isotherms of helium sorption by solid layers of condensed gas were previously determined at 4.2 and 2°K at pressures from 10^{-3} to 10^{-9} torr. In the investigation reported here an attempt was made to obtain a pressure of $\sim 1 \times 10^{-13}$ torr in an unheated system, and to calibrate a magnetron-type manometer in the pressure range from 10^{-5} to 10^{-13} torr. The pumping effect of N_2 and Ar layers at 10^{-5} to 10^{-13} torr was also investigated. The isotherms of helium sorption on N_2, Ar and CO_2 at 10^{-9} to 10^{-13} torr pressures were obtained. The isotherms indicate that the layers are capable of absorbing 5 to 10% of the helium at 10^{-9} to $^{-13}$ torr. (R.V.J.)

38234 (MLM-1653) SIMPLE, ECONOMICAL, HIGH-INTEGRITY HIGH-VACUUM SEALS. Birden, J. H. (Mound Lab., Miamisburg, Ohio). July 3, 1969. Contract AT(33-1)-Gen-53. 6p. Dep. CFSTI.

A seal was developed for use in ultrahigh vacuum systems and for containment of radioactive materials in storage containers. The seal is basically a metal foil which is used in conjunction with a precision-machined sealing surface. The foil can be reused several times with satisfactory results. Seals of nickel, tantalum, and gold were satisfactory for most purposes, while aluminum gave good results under certain conditions. (auth)

38235 (NP-17956) INVESTIGATION OF THE CRYOSORPTION PUMPING OF HELIUM, HYDROGEN, AND DEUTERIUM BY CONDENSED GAS LAYERS. Yuferov, V. B.; Kobzev, P. M.; Kholod, Yu. V. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1968. 25p. Dep.

An investigation was made of helium sorption on the sorbent gas layers in H_2, Ne, CH_4, N_2, O_2, Xe, Kr, Ar, and CO_2 in the temperature range 2 to 4.2°K and hydrogen and deuterium sorption on layers of N_2, Xe, Ar, and CO_2 at 20, 14, and 4.2°K. Sorption isotherms and isosters were obtained and specific pumping speeds were determined. The possibilities for development of the cryosorption pump that can operate in a wide pressure range pumping oilless vacuum systems are discussed. (M.O.W.)

38236 REDUCTION OF THE OUTGASSING OF THICK STAINLESS-STEEL SHEETS IN ULTRAHIGH VACUUM BY HIGH-TEMPERATURE VACUUM TREATMENT. Lewin, G. (Princeton Univ., N. J.). J. Vac. Sci. Technol., 6: 420-3 (May-June 1969).

Calculations are given for the reduction of H outgassing in thick stainless steel sheets by pretreatment in a vacuum furnace. These calculations are an extension of previous calculations for thin sheets (R. Calder and G. Lewin, Brit. J. Appl. Phys., 18, 1459 (1967)). The thick sheets are treated as semi-infinite slabs. (J.C.W.)

38237 SEALING LARGE ULTRAHIGH-VACUUM FLANGES WITH POLYTETRAFLUOROETHYLENE GASKETS. Danielson, P. M. (Argonne National Lab., Ill.). J. Vac. Sci. Technol., 6: 425-7(May-June 1969).

The application of polytetrafluoroethylene (Teflon) as a vacuum sealing material is discussed. A comparison of the properties of the teflon gaskets with copper gaskets is given. A procedure was performed to test the sealing capabilities of the teflon gaskets for two 12 in. Wheeler flanges. The tests indicated that the teflon gaskets could be substituted for copper to seal Wheeler flanges on ultrahigh-vacuum systems within a glove box if flange clamps are applied after the bakeout cycle; six flange clamps with 15 ft-lb of clamping torque are used, and higher concentration of hydrogen in the residual gas is not considered detrimental. (J.C.W.)

38238 ERRORS IN UHV PRESSURE MEASUREMENTS RESULTING FROM LEAKS. Young, J. R. (General Electric Co., Schenectady, N. Y.). J. Vac. Sci. Technol., 6: 428-9 (May-June 1969).

A leak was reported in the NASA Trigger-Discharge Gauge in

one of the ceramic feed-throughs, which was sealed with a silicone-resin leak sealer. Attempts to seal the leak in the feedthrough were unsuccessful. The leak could be reduced to a small value at room temperature but a bake at 200°C opened the leak. The gauge was tested for low pressure characteristics. After a 250°C bake, the leaking gauge indicated a current of 6×10^{-11} A and a working gauge registered 8×10^{-12} A. After applying a partially cured leak sealer, the current dropped to 1×10^{-11} A and the other gauge to 7×10^{-12} A. It was concluded that small leaks in gauges can produce a low pressure-measuring limit of the gauge while not noticeably limiting the achievement of UHV in the system. (J.C.W.)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 37977, 38378, 39638–39640, 39974, and 40398.

38239 (ACRH–1000-130) OPTICAL PROCESSING OF RADIONUCLIDE IMAGES. Beck, Robert N.; Charleston, Donald B.; Harper, Paul V.; Yasillo, Nicholas J. (Argonne Cancer Research Hospital, Chicago, Ill.). May 1969. Contract AT(11-1)-69. 21p. (CONF-690520–1). Dep. CFSTI.

From 7th National Biomedical Sciences Instrumentation Symposium, Ann Arbor, Mich.

The quality of radionuclide images is limited by the spatial resolution of the collimated radiation detector, noise due to random fluctuations in the signal level, and line structure due to the rectilinear scanning motion of the detector. Within the limits of a useful signal-to-noise ratio, such images can be altered in various ways by optical spatial filtering techniques. Sharpening is accomplished by removing the low spatial frequency components from the image, which (relatively) enhances the high frequency components. Smoothing of recorded noise is accomplished by removing the high frequency components that lie above the detector bandpass. Line structure is removed by a special filter that blocks the periodic pattern which characterizes the scan raster. In this pilot study, an inexpensive HeNe laser and simple lenses comprise the optical system. (auth)

38240 (AE–359) VANADIUM BETA EMISSION DETECTORS FOR REACTOR IN-CORE NEUTRON MONITORING. Andersson, I. Oe.; Soederlund, B. (Aktiebolaget Atomenergi, Stockholm (Sweden)). June 1969. 25p. Dep.

In-core flux measurements are becoming increasingly important in both power reactors and test reactors. In particular power distribution measurements in large power reactors have to be performed with a great number of neutron detectors capable of withstanding high integrated flux values. A summary of the development and application of a new type of nuclear radiation sensor, a beta emission detector, for measurements at high neutron flux levels is presented. The work has been carried out at the Section for Instrumentation (SSI) and has been the basis for a type of neutron detector employed in the Marviken in-core system as well as for other types. The design and principle of operation, experiments, and tests are described. Also included are the results and comments from a long-term irradiation of some detectors in the Halden Reactor. (auth)

38241 (AERE-Trans–1104) RADIOACTIVE CONTAMINATION IN WORKSHOPS AND LABORATORIES. VOLUME I. TECHNIQUES FOR DETECTION AND MEASUREMENT. Werderer, B. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated by E. M. Gillis (Atomic Energy Research Establishment, Harwell, Eng.), from report SPR/65-1475. 33p. Dep. CFSTI (U.S. Sales Only). UK 5s.

Techniques associated with the monitoring of water and of air are reviewed, together with techniques for the measurement of surface contamination, under the following headings: Units for estimation of contamination by fluids (concentration, accumulated activity); factors affecting the sampling of a fluid (homogeneous and heterogeneous dispersion, dispersion in space, effect of speed of sampling, sedimentation in sampling devices, adsorption on sampling devices); principles of measurement of fluids (direct measurement of sample, collecting activity present in a fluid, collecting atmospheric contamination, collection of aerosols, collecting activity present in water); interpretation of results (inhaled activity, long-lived sources of radiation); principal types of apparatus for measuring accumulated activity (discontinuous monitoring, continuous monitoring); apparatus for measurement of concentration (discontinuous monitoring equipment, continuous monitoring equipment without collection, principal types of contamination detector without collection, equipment combining continuous monitoring with collection); contamination of surfaces (generalized homogeneous contamination, localized contamination, principal detectors used); detection of non-static activity (procedures for suspension, procedures using transfer). 41 references. (UK)

38242 (ANL–7470) DETECTION OF TRANSIENTS IN NUCLEAR SURVEILLANCE-COUNTING CHANNELS. Porges, K. G. (Argonne National Lab., Ill.). Nov. 1968. Contract W-31-109-eng-38. 97p. Dep. CFSTI.

In certain nuclear-instrumentation problems, one must detect short excursions in a normally quasi-constant input count rate. A number of such transient detection systems are reviewed and one particular application, fuel-failure monitoring in connection with high-power density reactor cores is described in detail. The instrument generally incorporates a filter which must be arranged to optimize the display of the transient, or (where the channel output is used to actuate an alarm) to result in a specified detection efficiency and acceptable false-alarm frequency, in conjunction with an acceptable announcement delay. The design of such a filter is discussed and formulas are given for estimating the false-alarm frequency at a specified detection efficiency. An elementary formula turns out to be of dubious reliability when the normal background rate is low enough to yield only very few pulses within a time-span defined by the memory of the filter. A more precise formula is derived for such cases. Where the false-alarm frequency cannot be reliably reduced to an acceptable value and several independent detector channels are available, certain logic networks can yield improvements. A number of such logic interfaces are discussed and appropriate false-alarm frequencies derived. In connection with the optimum filtering problem, the beneficial effect of pulse-shape symmetrization is considered in detail. A simple digital channel is described which should provide improved performance parameters with considerably better long-term reliability than conventional analog equipment. (auth)

38243 (BMwF-FBK–69-20) EFFICIENCY AND CROSS SECTION OF CYLINDRICAL SCINTILLATORS IN AXISYMMETRICAL gamma-RAY FIELDS OF VARIOUS ANGULAR DISTRIBUTIONS. Keller, H.-J.; Schaarschmidt, A. (Frankfurt Univ. (West Germany). Institut fuer Angewandte Physik). May 1969. 202p. (In German). Dep.

A method is developed for the numerical calculation of efficiency and cross section of cylindrical scintillators in axisymmetrical γ-ray fields. After a comparative review of the approaches used hitherto the program is described in detail and the results for the following angular distributions of the radiation are shown in graphs: (1) isotropic radiation (1 × 1″ to 5 × 5″ NATON 136 and NaI(Tl), energy range from 10 resp. 100 keV to 100 MeV); (2) extended parallel beams at angles of 0°, 22.5°, 45°, 67.5°, and 90° to the axis of the scintillator (results plotted vs. u.R); (3) a field of multiply scattered γ-rays in an extended scattering medium (NaI, three initial energies), the angular distribution approximated by (a) a Gaussian distribution, (b) values by Berger (Appl. Phys., 26: (1955) 1504), and (c) Stehfest (Diplom. thesis Frankfurt/M. 1966), the direction of symmetry being parallel to the axis of the scintillator. Then the method is generalized to radiation fields of arbitrary angular dependence; results for oblique incidence of axisymmetrical radiation, again approximated by a Gaussian distribution with the direction of symmetry under the above mentioned angles to the axis of the scintillator, are presented (3 × 3″ and 5 × 5″ NaI, initial energy 1 and 5 MeV). (auth)

38244 (EGG–1183-1408) HIGH VOLTAGE MONITOR SYSTEM MANUAL. LVO Manual No. LB-123. Thompson, T. (EG and G, Inc., Las Vegas, Nev.). Oct. 11, 1968. Contract AT-(29-1)-1183. 22p. Dep. CFSTI.

Each critical (i.e., program triggering and critical coverage) detector high-voltage power supply in a typical diagnostic system is monitored to ensure that the voltage does not drift out of set limits. This monitor may be used to monitor any voltage within its range but was designed for and is used primarily with detector power supplies. The range of allowable voltage drift is set by positioning limit switches on a control-meter relay in the voltage monitor which is connected to the high voltage power supply output. The high-voltage monitors described are designed to provide an expanded scale, suppressed zero, meter indication in two ranges: 0 to 10 kV and 5 to 20 kV. In expanded scale, the 10-kV unit has a full scale deflection on the meter face of 200 V; the 20-kV unit has a full scale sensitivity of 2 kV. Five monitor modules and a power supply module are packaged in a standard nuclear instrument bin. Circuit description, specifications, and operating instructions for the High Voltage Monitor System are presented. (auth)

38245 (JLI–3506-41) BASIC DEVELOPMENT AND APPLICATIONS OF BUBBLE CHAMBERS FOR LOW LEVEL COUNTING. Final Report. Petroff, C. P.; Koski, W. S.; Waters, J. R. (Johnston Labs., Inc., Cockeysville, Md.). Jan. 31, 1969. Contract AT(30-1)-3506. 104p. Dep. CFSTI.

It is shown that a heavy liquid bubble chamber can be used as a detector of low level radioactivity with properties comparable to or better than currently existing low level counting systems. Initial work on a simple manually controlled system using Freon

13B1 and propane as chamber fluids demonstrated proof of principle. Propane was then used in an automatically operating system in chambers of glass and quartz of 5 to 15 ml volume. The chamber operated at 55°C. After expansion, so that the propane became superheated, the time delay to boiling was measured and recorded. Boiling was sensed by the sudden rise in pressure actuating a strain gauge pressure transducer; the tracks were not photographed. It was found that three plateaus existed in the plot of chamber counting rate against the superheat pressure (difference between vapor pressure at 55°C and pressure to which chamber was expanded). These were shown to be due to sensitivity to alpha particles (superheat pressure 30-40 psi), recoil protons (50-90 psi), and electrons (140-220 psi). The chamber background counting rate was shown to be stable over periods of weeks and reproducible when the chamber filling was changed. The background count rate when sensitive to fast neutrons was approximately 0.7 cpm for a 10 ml propane filling inside an 8'' iron shield. When sensitive to electrons, the background was 11 cpm under the same conditions. It was demonstrated that the chamber counting rate was proportional to the tritium activity in it with an efficiency of 65% so making it suitable as a low level counter. Tritium detection showed a flat plateau from 200 to 220 psi superheat pressure. While operating on the electron plateau, the chamber is sensitive to the penetrating cosmic radiation which can be eliminated using guard counters in anticoincidence. The net background rate for a 10 ml quartz chamber shielded by 2'' of borated paraffin and 8'' of iron was 4.5 cpm. The bubble chamber system is compared with other low level counting systems by means of a frequently used figure-of-merit. Recommendations are made for future developments using larger chambers of a useful size for research in the low level counting field. (auth)

38246 (KAPL-M-6961) NUCLEAR REACTOR NEUTRON DETECTION AND MEASUREMENT DEVICES. Lewis, Emanuel (Knolls Atomic Power Lab., Schenectady, N. Y.). Oct. 1968. Contract W-31-109-eng-52. 110p. Dep. CFSTI.

Properties of neutrons are described including interactions of neutrons with matter, nuclear cross sections, variation of cross section with neutron energy, and slowing down of neutrons. Reactions used to detect thermal and epithermal neutrons are discussed including charged particle reactions, fission reactions, and induced radioactivity; and reactions used to detect fast neutron are discussed including proton recoil and threshold reactions. Also, the operation and performance of neutron detectors are described. Ionization chambers, proportional counters, semiconductor detectors, thermopiles, activation foils, and self powered detectors (reaction initiated current flow) are considered. Advantages and disadvantages of each detector for reactor control and monitoring and reactor experimentation are discussed. (142 references). (W.H.K.)

38247 (LA-4126) RECENT ADVANCES IN FAST-RESPONSE MINIATURE NEUTRON FLUX MONITORS. Stillman, D. B.; Chaney, R. L. (Los Alamos Scientific Lab., N. Mex.). Mar. 4, 1969. Contract W-7405-eng-36. 12p. Dep. CFSTI.

A fast response miniature neutron detector has been developed at the Los Alamos Scientific Laboratory (LASL) to measure temperature-time history of fissile materials under intense neutron irradiation. The fissile-sensing element of the fission couple neutron detector is approximately 0.030 in. in diameter. The detector sensitivity for thermal neutrons is approximately 10^9 n/cm^2-°C. To determine any limitations in response time, fission couples were placed 3 m from a nuclear device in an underground nuclear weapons test at the Nevada Test Site. The detector accurately followed the change in neutron population (alpha measurement) as the device exploded. This rapid change in neutron population had an e-folding time of 20 nsec. A number of experiments were performed in various reactors so that such a detector could be developed. These experiments were conducted in a particular sequence and were aimed at investigating the characteristics, possible uses, and limitations of the fission couple. Some experimental results are discussed. The significance of the results obtained with fission couples suggests numerous applications in neutron diagnostics and reactor controls. The most obvious application for this instrument would be mapping of the neutron flux in and around a reactor. Other possible applications are also discussed. The miniature size and fast response of a fission couple combine to offer unique advantages as a new tool in reactor diagnostics and control. (auth)

38248 (ORAU-108) COUNTING CHARACTERISTICS OF A MEDIUM-LEVEL WHOLE-BODY COUNTER. Kakehi, Hirotake; Gibbs, W. D.; Hayes, R. L. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.). Aug. 1969. 29p. Dep. CFSTI.

The operational characteristics of the diagnostic-level whole-body counter developed at the Oak Ridge Associated Universities, Medical Division are described. This instrument consists of four 3-in. diameter × 3-in. thick sodium iodide crystal detectors mounted in a 1¼-in. thick trough-like lead shield and was designed to measure radionuclides in humans in the range from 0.1 to 100 microcuries. Experiments performed and results obtained with the medium-level whole-body counter in a search for distribution-independent energy bands for counting a number of different radionuclides are discussed. (W.H.K.)

38249 (UCRL-50653) METHOD FOR DETERMINING SCINTILLATOR RESPONSE FUNCTIONS FOR FAST NEUTRONS. Pohl, B. A.; Anderson, J. D.; McClure, J. W.; Wong, C. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 29, 1969. 10p. Dep. CFSTI.

An efficient method for determining the pulse-height response function of organic scintillators for fast neutrons has been developed. A pulsed beam of 14 MeV neutrons from the D–T reaction was generated by the Livermore ICT accelerator; the beam of neutrons was subsequently degraded by scattering in a one mean-free-path block of CH_2 to produce a time-correlated polyenergetic burst of neutrons. The neutrons were detected at a flight path of 7.5 m with a full width at half maximum (fwhm) time resolution of 3 nsec. The timing error due to the scattering process was negligible compared to the total flight time. Both time-of-flight and pulse-height information were accumulated for each detected event in a two-parameter analyzer. Using this method, the response functions were measured for Stilbene, Pilot B, NE-213, and NE-218 for neutrons with energies between 1 and 14 MeV. From these functions the loci of equivalent electron pulse heights were determined for each scintillator. (auth)

38250 EXPERIMENTAL PROPERTIES OF HIGH ENERGY ELECTRON BEAM MONITORS. Ohama, Taro; Yanagisawa, Takeshi (Mitsubishi Electric Corp., Amagasaki, Japan). Mitsubishi Denki Giho, 43: 739-45(May 1969). (In Japanese).

A Faraday cup, a secondary electron monitor and a profile monitor have been manufactured as a high energy electron beam monitor used in an energy region over 30 MeV. The Faraday cup and the secondary electron monitor are used for measuring electron beam current. The profile monitor is to observe the spread of electron beam in a beam transport system. The Faraday cup being taken as reference, efficiency of the secondary monitor is measured by using an electron beam energy, electron beam average current and collecting voltage as parameters. Also characteristics of the profile monitor in the energy of about 60 MeV have been studied by the use of the beam transport system. As a result of the above experiment, it has been confirmed that these monitors will operate in conformity to an initial aim. (auth) (NSA of Japan)

38251 LOWLEVEL RADIATION MONITOR. Splichal, W. F. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,461,292. Aug. 12, 1969.

An improved device for measuring low-level or background ionizing radiation is described. The device comprises an ionization chamber circuit, including an electrostatic relay to sense the voltage across the ionization chamber and providing a coupling means between the chamber circuit and a readout circuit, and a by-pass relay means connected to the chamber in parallel with the electrostatic relay. The by-pass relay is energized by a signal from the readout circuit and is adapted to recharge the ionization chamber. This by-pass relay permits an ionization chamber having a relatively large capacitance to be used and will completely recharge the chamber after each counting cycle. (AEC)

38252 SHAPING THE PULSES OF RADIATION DETECTORS. Stanek, F. W. (Oskar-von-Miller-Polytechnikum, Munich). Kerntechnik, 11: 159-66(Mar. 1969). (In German and English).

Various aspects involved with pulse shaping in radiation detectors are discussed. Topics include information content of electric pulse signals, mathematical description of components and of stages, and pulse shaping and pulse amplification. (B.G.D.)

38253 A GM COUNTER SYSTEM FOR LOW LEVEL β COUNTING. Tin Aye Nyein; Zin Aung; Skrivanek, J. (Arts and Science Univ. Rangoon). Union Burma J. Sci. Technol., 1: 365-8(Aug. 1968).

The design and operation of a Geiger–Mueller counter with anticoincidence gamma counters for low-level beta counting are described. (W.H.K.)

38254 THE SPACIAL DISTRIBUTION OF β-RADIATION DOSE UPTAKE BY A TISSUE-EQUIVALENT MEDIUM. Narkevich, B. Ya.; Konstantinov, I. E.; Golavachik, V. T. (Moscow Engineering-Physics Inst.). Med. Radiol., 14: No. 7, 50-4 (July 1969). (In Russian).

The measurement of the field of absorbed doses of $^{90}Sr-^{90}Y$

β-radiation in a tissue-equivalent medium is discussed. A scintillation β-spectrometer is described for these measurements. Results of the energy scale of the spectrometer, as well as data of measurements of the spatial distribution of absorbed doses of β-radiation in a tissue-equivalent phantom are presented. (auth)

38255 SMALL SCINTILLATION DETECTOR WITH PHOTOMULTIPLIER FEU 35. Boucek, J. Cesk. Radiol., 22: 335-7 (Sept. 1968). (In Czech).

A scintillation probe with a FEU 35 photomultiplier tube in combination with a simple stand facilitating movement in all directions was developed for experimental work with small animals. A simple collimator can be attached to the probe, its shape depending on the required direction characteristics. (auth)

38256 A DEVICE FOR PLOTTING SCINTIGRAMS. Donato, Luigi; Giordani, Roberto; Gennaro, Gianni; Salvadori, Piero (to EURATOM. Universita Degli Studi Di Pisa). British Patent 1,158,917. July 23, 1969. Priority date Aug. 17, 1965, Italy.

A device is described for plotting scintograms from scintillation scanners used for presenting a graphic distribution of radioactivity in an organ, a whole body, or a section of a body. (B.G.D.)

38257 DESIGN OF COUNTING SYSTEMS FOR DYNAMIC STUDIES AND UPTAKE MEASUREMENTS. Trott, N. G.; Williams, H. S.; Brown, N. J. G. (eds.). British Journal of Radiology: Report Series No. 3. London, British Institute of Radiology, 1968. 88p. 41s. 3d.

The symposium included papers on general criteria in counter design, investigations of wide angle collimated detectors, methods of reducing edge penetration and septal penetration in multihole collimators, design and evaluation of collimators for radioisotope cameras, role of the scintillation camera in dynamic studies, thyroid uptake studies, design and use of a counting system for thyroid uptake measurements, advantages of using rotating detectors for measuring thyroidal activity, uptake of radioiodine by thyroid gland, the radioactive isotopic renogram, the renogram collimator maze, general review of circulation studies, system for analysis of data from radioactive gas clearance studies, evaluation of equipment for cerebral circulation studies with ^{133}Xe collimators for radioisotope (^{133}Xe) studies of lung function during exposure to positive acceleration, and a proposal to standardize the evaluation of all counters. (UK)

38258 DESIGN, CONSTRUCTION, AND USES OF WHOLE BODY MONITORS. Duggleby, J. C. (Commonwealth X-Ray and Radium Labs., Melbourne). Australas. Bull. Med. Phys. Biophys., No. 40, 3-13(June 1969).

The historical development of whole body monitors is discussed, together with the shielding required and the detectors and analyzers available. The construction of the Commonwealth X-ray and Radium Laboratory whole body monitor is outlined. This monitor uses sodium iodide crystals as well as plastic scintillators and has laminated steel shielding. Mention is made of the projected use of the facility in measuring the ^{137}Cs content in fallout studies of the Australian population. The usefulness of whole body monitors in determining the amounts of various radioisotopes in the body is discussed, especially with reference to measurement of ^{40}K content for studying dietary weight loss and potassium deficiencies, and the uptake and retention of iron and calcium over long periods. (Australia)

38259 STUDY OF THE PULSED LIGHT OF A G–M COUNTER DISCHARGE. Bonchev, Z.; Starbova, D.; Iordanov, A. God. Sofii. Univ., Fiz. Fak., 61: 69-83(1966-67). (In French).

A photomultiplier was used to study the light from a G–M counter discharge. Two types of counters were studied, a series VAZ-320 (RDA) and one joined to a vacuum installation by means of which the composition and pressure of the mixture of gases in the counter can be varied. Only light from the visible part of the spectrum was recorded. This light is considered related to the total light emitted in the discharge. Among the relations shown are the degree of blackening of the plate as a function of the distance from the anode and the relation of the ratio of the light intensity to the quantity of light emitted by a unit of electric charge which crosses the counter with the voltage of the counter. (J.F.P.)

38260 AUTOMATIC PLOTTER OF THE GEIGER COUNTER PLATEAU. Mihele, V. (Bucharest Inst. of Nuclear Physics). Stud. Cercet. Fiz., 21: 111-18(1969). (In Rumanian).

The principle and the construction of an analog device for the measurement and recording of the counting characteristic of G.M. counters are described. The device can control as many as 30 counters at a time, submitting them to a temperature program which includes up to 12 predeterminated points at which measurements are made. The duration of the program varies from 30 minutes to 24 hours, the temperature range being from 25 to 180°C. (auth)

38261 IRRADIATION CONTROL BY MEANS OF COLOR RADIOFIELDGRAPHY. Sunada, Tsuyoshi (Radiation Center of Osaka Prefecture, Sakai, Japan). Genshiryoku Kogyo, 15: No. 2, 34-8(Feb. 1969). (In Japanese).

A convenient tool to measure the intensity of radioactive irradiation in terms of color variation was developed and applied to irradiation control. When dyes which are used as pH indicator, such as aniline blue, aniline yellow, and benzene azo α-naphthylamine, are added to the film of polyvinyl chloride, the film color changes from light green, to yellow, to orange, to red, and to purplish red with the increase of exposure rate. As a cubic sensitive material, agar-agar is recommended as base component here. To agar-agar, indigo carmine, naphthol yellow, and TTC were added, or indigo carmine and resazurin were added. In case the former prescription was adopted, the material color changed from yellow, to orange, to red, and to purplish red with exposure rate, while in the latter one, the color changed from blue, to purple, to red, and to white. Using this cubic sensitive material, the distribution of intensity of a 14 MeV electron beam from a linear electron accelerator was easily observed. In irradiating the samples on a conveyor, the range of electron beam and the exposure dose distribution are clearly observed by this method, so that useful and appropriate data for selecting irradiation conditions can be obtained. (NSA of Japan)

38262 SINGLE AND DOUBLE HEADED DETECTOR SYSTEMS FOR SCANNING. Kibby, P. M. (Hammersmith Hospital, London). Int. J. Appl. Radiat. Isotop., 20: 617-18(Aug. 1969).

Popovic and Fowler (loc. cit., 19: 313(1968)), in a comparison of single and double headed detector systems, show that the target/non-target ratio for a particular double headed system is greater than that for a particular single detector system at all depths. Circumstances under which the probability of detection of a lesion is higher for single than for double headed systems are pointed out. (auth) (UK)

38263 SINGLE AND DOUBLE HEADED DETECTOR SYSTEMS FOR SCANNING. Fowler, J. F. (Hammersmith Hospital, London); Popovic, S. Int. J. Appl. Radiat. Isotop., 20: 618(Aug. 1969).

A reply is made to the communication on this subject by P. M. Kirby (loc. cit., 20: 617-18(1969)). (UK)

38264 RADON LEAKAGE FROM RADIUM SOURCES. Haque, A. K. M. M. (Borough Polytechnic, London). Phys. Med. Biol., 14: 497-8(July 1969).

Some measurements are reported of radon leakage rate from radium sources using a low level scintillation counter. Some constructional details of the counter are given, the method of operation and calibration is described, and some typical results are presented. A set-up potential of -60 V is applied to an Al layer of thickness about 10 nm evaporated on to the ZnS scintillator, leading to almost 100% collection of radon daughter products. The technique involved in the calibration procedure is to remove radon from standard $RaCl_2$ solution at room temperature by a stream of aged air passing through a sintered glass disk immersed in the solution. (UK)

38265 TEST FACILITY FOR LARGE SUPERCONDUCTING STRIPS. Wittgenstein, F.; Feldmann, M.; Herve, A. (CERN, Geneva). Cryogenics, 9: 158-64(June 1969).

A hydrogen bubble chamber, called BEBC, with a hydrogen volume of about 33 m^3 is to be set up at CERN. The chamber will be surrounded by a magnet designed to produce a field of 3.5 T homogeneous to within ±3% over the cylindrical volume of the chamber. In order to define and test the major parameters of the conductor to be used to wind the BEBC magnet, a facility to test samples of proposed conductors was built, consisting of two main elements; superconducting magnet (split coil arrangement) producing a central field of 6 T in a free bore of 364 ϕ; and a test jig inserted into the magnet which allows samples to be exposed to the 6 T field, to be fed with a maximum current of 20 kA, and at the same time to be stretched with a maximum force of 8 tons. The behavior of large superconducting strips exposed to magnetic fields and mechanical forces was studied. (UK)

38266 EVALUATION OF SOME LARGE AREA SILICON JUNCTION DETECTORS FOR CRYOGENIC APPLICATIONS. Nichols, H. H. (Lockheed Georgia Nuclear Lab., Marietta); Palms, J. M. Nucl. Appl., 7: 164-9(Aug. 1969).

The use of semiconductor detectors with beta sources for determining local densities in cryogenic liquids has led to an investigation of the pulse-height response of several large area (2 cm^2) surface barriers and diffused junction silicon detectors for beta particles in the temperature range 300 to 22.2°K. (B.G.D.)

38267 RECOMBINATION IN IONIZATION CHAMBERS IRRADIATED WITH PULSED ELECTRON BEAMS. II. THE EFFECT IN THE FARMER THIMBLE CHAMBERS. Ellis, R. E.; Read, L. R. (Medical Coll. of St. Bartholomew's Hospital, London). Phys. Med. Biol., 14: 411-16(July 1969).

The effects of recombination in Farmer 0.6 and 0.2 cm^3 ionization chambers when irradiated with pulsed electron beams from about 1 to 50 esu cm^{-3} per pulse were studied. Polarizing voltages from 12 to 1200 V were applied and the results compared with the theory of J. W. Boag for ideal cylindrical chambers. Close agreement was obtained between theory and experiment for a value of the constant μ = 1000 V cm esu^{-1}. Reasons are put forward to explain this value of μ. (auth) (UK)

38268 SECONDARY STANDARD INSTRUMENTS FOR THE ACTIVITY MEASUREMENT OF PURE β EMITTERS. A REVIEW. Lowenthal, G. C. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Int. J. Appl. Radiat. Isotop., 20: 559-68(Aug. 1969).

The use of calibrated ionization chambers and counters for the standardization of the activity of pure or nearly pure beta emitters with maximum beta energies in the range up to 700 keV approximately is reviewed. With minor exception, only those instruments are considered which permit the attainment of reproducibilities well within ±2%, and their designs are discussed in regard to stability, sensitivity and ease of operation. So far no instrument combines these three characteristics in a really satisfactory manner, but further improvements seem possible, and would be desirable. (auth) (UK)

38269 APPRAISAL OF THE CORRELATION TECHNIQUE APPLIED TO THE MEASUREMENT OF LOW LEVELS OF RADIOACTIVITY. Edwards, A. (Radiological Protection Service, Sutton, Eng.). Int. J. Appl. Radiat. Isotop., 20: 569-75(Aug. 1969).

The theoretical claims for the Bradley–Marks correlation ratemeter, as applied to the measurement of low levels of radioactivity, were investigated experimentally. A brief theoretical argument is given to show that the claims conflict with the generally accepted principles of statistics. The results of experiments performed with apparatus loaned by Bradley show that measured variances smaller than those expected from ratemeter theory can be obtained, but that they are caused by the overloading of the correlation ratemeter. It is further shown that this overloading causes an alteration in the calibration of the instrument sufficient to remove the apparent advantage. It is, therefore, concluded that the instrument has no advantage over a conventional ratemeter for Poisson inputs. (auth)

38270 TEFLON VIALS FOR LIQUID SCINTILLATION COUNTING OF TRITIUM SAMPLES. Calf, G. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Int. J. Appl. Radiat. Isotop., 20: 611-12(Aug. 1969).

In automatic liquid scintillation spectrometers glass or polythene vials are normally used. With glass vials a considerable proportion of the background count is due to the ^{40}K encountered of the glass. Polythene vials distort after prolonged storage with aromatic hydrocarbons and can be troublesome in the automatic change mechanism. Since Teflon is inert to the solvents used in scintillation counting methods, and should give a lower background count, Teflon vials suitable for automatic liquid scintillation spectrometers have been fabricated from solid Teflon rod. A Teflon cap fitted with an O-ring is used to seal the vial. Comparison of these vials with other commercially available counting vials is reported in this note. (auth) (UK)

38271 POLAROID FILM PHOTO-RECORDING TECHNIQUE FOR MEDICAL RADIOISOTOPE SCANNERS. Kemplay, J. R. (Royal Postgraduate Medical School, London). Phys. Med. Biol., 14: 487-90(July 1969).

The system described provides a well resolved photographic display by a relatively simple method applicable to single and double-detector scanners. It is based on a Polaroid Land camera with a four-lens unit, which provides four pictures at different aperture settings and immediately a scan is completed. Two potentiometers attached to the scanning mechanism provide x and y coordinate position voltages which move the spot across the screen of an oscilloscope. The spot is brightened only by scintillation pulses passing the gate of the pulse-height analyzer, and thus a pattern of dots is built-up on the film. (auth) (UK)

38272 COMMENTS ON THE AGEING EFFECT OF GAS-FILLED PROPORTIONAL COUNTERS. den Boggende, A. J. F.; Brinkman, A. C.; de Graaff, W. (Space Research Lab., Utrecht). J. Phys., E (London), 2: 701-5(Aug. 1969).

A number of experiments are described which verify the suggestion that the changes occurring in the pulse-height distribution of proportional counters after 10^8 to 10^{10} counts can be explained by assuming the accumulation of a deposit on the anode wire. The counters were irradiated with monochromatic radiation of 2.1, 5.4 and 8.34 Å. Ar–10% CH_4 and Ar–20% CO_2 were used as counter gases; the changes were less pronounced with CO_2 than with CH_4. An x-ray fluorescence analysis of the deposit on the wires of some of the CH_4 counters showed the presence of carbon. Some possible sources for the deposit material are discussed. (auth) (UK)

38273 USE OF A WHOLE-BODY SPECTROMETER FOR ESTIMATING THE NEUTRON FLUX FROM THE INDUCED ^{24}Na ACTIVITY. Sivintsev, Yu. V.; Yuzgin, V. S. At. Energ. (USSR), 26: 471-2(May 1969). (In Russian).

Operations with fissionable materials may result in emergency situations which require an estimation of the total neutron dose. This may be achieved by using the correlation between the total neutron dose and the amount of activated sodium in the human body. The activity of ^{24}Na in the whole body may be determined from the activity of the blood sample taken from the victim, or by using a whole-body counter. The photoefficiency of a single-crystal whole-body spectrometer was evaluated by means of a Monte Carlo computer program. The calculations were made at γ quantum energies of E_γ = 2.76-MeV and by using a source which mocked up the "standard human body," containing uniformly distributed ^{24}Na. The lowest γ activity that could be recorded was determined as a function of the time of measurement and the prevailing background for a 0.95 confidence level. It was assumed that the time of irradiation was much shorter than the half-life of ^{24}Na. Neutron fluxes, from 100×10^6 n/cm^2 for thermal neutrons to 2.6×10^6 n/cm^2 for fast neutrons, corresponding to a dose of 100 mRem/week may be measured by determining the activation of sodium in the human body. (TTT)

38274 LOW GAIN PREAMPLIFIER (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1897).

9 drawings.

For negative input for radiation detectors with large C output, this inverting charge-sensitive preamplifier is used. The circuitry is constructed on a printed circuit board ~2 in. by 4 in. which is housed in a mini-box ~4 in. by 2¼ in. by 2¼ in. The box snaps apart exposing both sides of the circuit board affording easy removal and servicing. The output is positive 10 V max into a 50 ohm load. Rise time <20 n sec. Open loop gain is ~3300 with open loop rise time ~20 μsec. Sensitivity is ~.02 V/pC with 51pF. A low ripple power supply is employed to prevent ripple coupling with the output or an active filter circuit must be used. Power requirements are +24 Vdc with 19 mA or –24 Vdc with 17 mA. (For details see TID-4100 Suppl. 54). (F.S.)

38275 GAMMA- AND NEUTRON-GAMMA MEASUREMENT CORRELATIONS. Deres, J.; Marhoffer, J. Magy. Geofiz., 10: 32-8(1969). (In Hungarian).

Difficulties encountered during calibration of Geiger–Mueller counters are discussed. Various types of devices are compared with Geiger–Mueller counters and scintillation detectors. A description is given of a device constructed in Hungary as a standard for determining the results obtained with the Geiger–Mueller counter. Data are given on the results of field work for confirming energy distribution measurements of gamma radiation measured with this standard device. Calibration curves for the standard device are included. (R.V.J.)

38276 GENERAL RECOMBINATION IN A STANDARD PARALLEL-PLATE FREE-AIR IONIZATION CHAMBER. Boag, J. W. (Inst. of Cancer Research, Sutton, Eng.). Int. J. Radiat. Phys. Chem., 1: 267-85(July 1969).

The recombination loss in a free-air standard ionization chamber operating near saturation is calculated on the assumption of a Gaussian radial distribution of ionization intensity. It is shown that the recombination loss is independent of the half-width of the distribution, and a relatively simple general relationship is deduced, which is valid when space charge is negligible. The screening effect of space charge is then considered and formulae for appropriate correction factors are developed. (auth) (UK)

38277 ROUTINE MEASUREMENT OF LOW-LEVEL ACTIVITIES USING END-WINDOW GEIGER-MUELLER COUNTERS IN THE MINIMUM DISTANCE BY UTILIZING THE BETA-RAY BACKSCATTERING BY LEAD. Dreusicke, M.; Niepel, J. (Bezirksinstitut fuer Veterinaerwesen, Potsdam, Ger.). Isotopenpraxis, 5: 134-6(Apr. 1969). (In German).

The conditions for attaining beta-counting efficiencies of 41% for ^{90}Y (thickness 8.4 mg/cm^2) and of 32% for ^{137}Cs (thickness 10.8 mg/cm^2) with a Geiger–Müller end window tube are dis-

cussed. Special regard was given to the combination of the measuring device VA-M-16D with the Czech sample changer NCZ 616A. (auth)

38278 SCANNER STAND FOR PULMONARY FUNCTION STUDIES. Brown, I. K. (Walton Hospital, Liverpool); Kirk, F.; Seaton, A. Brit. J. Radiol., 42: 545-8(July 1969).

The design of a radioisotope scanner stand for moving or static lung scanning is described. (W.H.K.)

38279 IMPROVEMENTS IN AND RELATING TO METHODS OF MANUFACTURING MONOGRAIN LAYER DEVICES. (to Philips Electronic and Associated Industries Ltd.). British Patent 1,158,923. July 23, 1969. Priority date Aug. 4, 1965, Netherlands.

Reference is made to devices for operation as radiation detectors such as photodiodes and photo-resistors, or for the conversion of radiation energy into electrical energy (e.g., solar batteries), or for the conversion of electrical energy into radiation energy in the form of electroluminescence. In such devices it is of advantage to use layers of grains having the thickness of substantially only one grain, in order to reduce contact resistance between the grains, and to avoid screening of grains against radiation by other grains. Such devices may be constructed using grains comprising p–n junctions. In such semiconductor diodes the p–n junction must be located in a monocrystal and should have a minimum surface area. Some semiconductor materials cannot readily be obtained in this form, but can be manufactured in a sufficiently pure form as powders consisting of monocrystalline grains. In such cases a layer of grains may be used, the p–n junctions in the grains between the electrode layers being connected in parallel and together having the desired total surface area. A method is described for manufacturing a device comprising a layer of grains having substantially the thickness of one grain, with an insulating filler between the grains. The grains, at least on one side of the layer where an electrode layer is to be provided in contact with the surface of the grains, are embedded in a photoresist, which is hardened from the opposite side of the layer of grains using radiation selected with regard to the permeability to radiation of the grains and of the filler material so that on that side at least the parts of the photoresist covering the grains remain soluble in an appropriate developer, and after renewal by the developing process provide exposed grain surfaces for contact with the electrode layer. See also British Patents 1,158,922 and 1,158,924. (UK)

38280 IMPROVEMENTS IN AND RELATING TO DEVICES COMPRISING A LAYER OF RADIATION SENSITIVE OR RADIATION EMITTING GRAINS. (to Philips Electronic and Associated Industries Ltd.). British Patent 1,158,922. July 23, 1969. Priority date Aug. 4, 1965, Netherlands.

Reference is made to devices for operation as radiation detectors, or for the conversion or radiation energy into electrical energy (e.g., solar batteries), or for the conversion of electrical energy into radiation energy (e.g., by recombination radiation at p–n junctions in semiconductors, or by electroluminescence, or other means). In all these cases it is of advantage to use layers of grains having a thickness of substantially only one grain, so that contact resistance between grains is avoided and so that efficiency is increased due to the absence of grains screened against radiation by other grains. A problem which occurs with such devices is that at least one electrode must be provided on the sensitive and active layer, respectively, which must meet the conflicting requirements of having little lateral resistance and forming little or no obstruction for the radiation incident on or emerging from the layer. The disadvantages of previous attempts to solve this problem are outlined; the system described seeks to avoid these difficulties by providing an electrode having an inhomogeneous structure such that the parts in contact with the grains are readily permeable to radiation of a particular wavelength range, whereas the parts between grains are of higher conductivity and less permeable. The device comprises a layer of radiation sensitive or radiation emitting grains having an insulating filling substance between the grains and at least on one side of the layer an electrode which is permeable to radiation of a particular wavelength range, this electrode comprising a pattern of coherent electrically higher conductive regions on the insulating filling substance between the grains and of lower conductive regions on the grains, the higher conductive regions being less permeable to the radiation than the lower conductive regions. The lower and higher conductive regions may comprise thinner and thicker portions of the electrode. The method of manufacturing such a device by etching is described. The grains may consist of sulphide, with exposed portions chemically converted to sulphur. The required pattern is formed by a photoresist method. (See also British Patents 1,158,923 and 1,158,924). (UK)

38281 AMPLIFICATION OF GAS-DETECTOR IMAGES. Lansiart, Alain; Morucci, Jean-Pierre; Roux, Georges (to Commissariat a l'Energie Atomique). British Patent 1,159,609. July 30, 1969. Priority date Nov. 27, 1965, France.

A gas-filled detector is described which consists of a cathode, and intermediate electrode, and an anode and operates with an image intensifier which is adapted to transmit and amplify the luminosity of images from glow discharges between the intermediate electrode and the anode caused by electron avalanches initiated by secondary photons and a method for recording the amplified images. The gas used in this detector is a xenon-methylal mixture where the respective partial pressures of xenon and methylal are in the vicinity of 730 and 30 torr. (B.G.D.)

38282 IMPROVEMENTS IN AND RELATING TO METHODS OF MANUFACTURING DEVICES COMPRISING A LAYER OF GRAINS. (to Philips Electronic and Associated Industries, Ltd.). British Patent 1,158,924. July 23, 1969. Priority date Aug. 4, 1965, Netherlands.

Reference is made to devices for operation as radiation detectors such as photo-diodes and photo-resistors, or for the conversion of radiation energy into electrical energy (e.g., solar batteries), or for the conversion of electrical energy into radiation energy (e.g., by recombination radiation in semiconductor p–n junctions or by electroluminescence). In such devices it is of advantage to use layers of grains of substantially one grain thickness, in order to avoid contact resistance between grains and also to avoid the screening of grains against radiation by other grains, and a support should be provided for the grains and binder to give mechanical rigidity. In many cases it is desired to provide an electrode layer on the layer of grains, in electrical contact with the grains on the side of the layer adjacent to the support. This may be done by using a support which is conductive at least over the part of its surface to be covered with the layer of grains. It is essential that on the side of the support the surface of the grains is at least in part free from binder material, to avoid high or unstable contact resistance; this is difficult to achieve in practice. In the manufacturing method described a liquid adhesive layer is provided on a support in which the layer grains are sunk over part of their diameter, a binder is provided between the grains and then hardened, the layer of grains with the binder is detached from the support by selectively removing the adhesive layer, and an electrode is provided on the surface parts of the grains exposed on removal of the adhesive layer. The adhesive layer may be gelatine or saccharose/glucose, and an intermediate layer of nitrocellulose or lecithin may be interposed between the support and the adhesive layer. (See also British Patents 1,158,922 and 1,158,923). (UK)

38283 MULTISTAGE SELF-IMPROVING MONTE CARLO METHOD. Baldini-Celio, R.; Ballico-Lay, B.; Spano-Mencuccini, M. A. (CNEN, Frascati, Italy). Nucl. Instrum. Methods, 72: 317-20(1969).

A technique to speed up the application of the Monte Carlo method to calculate the detection efficiency of a physical process by an experimental apparatus is described. The calculation goes through more stages. At each stage the Monte Carlo obtains informations, by its own results, which allows itself to reduce the variance in the next stage by means of a weighted sampling technique. Then it is possible to achieve the same results as a crude Monte Carlo in a running time about 100 times shorter. (auth)

38284 DETECTOR FOR THE MEASUREMENT OF NEUTRON ELASTIC CROSS SECTIONS IN THE RESONANCE ENERGY REGION. Trochon, J.; Asghar, M.; Lucas, B.; Ribon, P. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nucl. Instrum. Methods, 72: 307-13(1969). (In French).

A detector for the measurement of neutron elastic scattering cross sections in the resonance energy region is described. It consists of 5 Jackson and Thomas type ^{10}B loaded liquid scintillators suitably placed around the neutron scattering sample. The pulse shape discrimination technique is used, which reduces the γ-ray response of the scintillators by 99.9%, while losing only 8% of neutrons. The scattering data on ^{103}Rh and ^{197}Au are presented and a comparison is made with the results from other existing detectors. Further improvements in the system are suggested. (auth)

38285 DETERMINATION OF ZERO VELOCITY FOR A CONSTANT ACCELERATION MOESSBAUER SPECTROMETER. Carrell, J. C.; Mazak, R. A.; Collins, R. L. (Univ. of Texas, Austin). Nucl. Instrum. Methods, 72: 298-300(1969).

It has been suggested that the zero of velocity cannot be determined with precision for Moessbauer spectrometers operating in the constant acceleration mode. Two methods for this determination are described. One utilizes the convergence of a multiline

spectrum, with increasing velocity range, toward the zero velocity position. The second utilizes the intersection of spectra taken at different velocity ranges. (auth)

38286 ATTENUATION OF PROPORTIONAL COUNTER PULSE. Mathieson, E. (Leicester Univ., Eng.). Nucl. Instrum. Methods, 72: 355-6(1969).

The attenuation of a proportional counter pulse by non-interacting RC integrating and differentiating networks has been computed. A table is presented extending previous calculations which were restricted to equal time constants. (auth)

38287 METHOD FOR CHEMICAL SURFACE TREATMENT OF Ge(Li) p-i-n DETECTORS. Korf, H.; Schmand, J. (Univ., Muenster, Ger.). Nucl. Instrum. Methods, 72: 353-4(1969). (In German).

A reproducible method for chemically forming the surfaces of Ge(Li) detectors is described. Most of the Ge detectors were well suited for γ-spectroscopy. (auth)

38288 CALCULATION OF EFFICIENCY AND CROSS SECTION OF CYLINDRICAL SCINTILLATORS IN RADIATION FIELDS OF ARBITRARY ANGULAR DEPENDENCE. Schaarschmidt, A.; Keller, H.-J. (Johann-Wolfgang-Goethe-Univ., Frankfurt am Main). Nucl. Instrum. Methods, 72: 291-7(1969).

In a previous paper a computational method for the accurate numerical calculation of efficiency and cross section of cylindrical scintillators in axisymmetrical radiation fields with direction of symmetry parallel to the scintillator axis was developed. This method is generalized to radiation fields of arbitrary angular dependence. Sample results are presented for 3 in. × 3 in. and 5 in. × 5 in. NaI scintillators in fields of multiply scattered γ-radiation with oblique direction of symmetry (initial energies E_0 = 1 and 5 MeV). The angular distributions of this radiation are approximated by Gaussian exponential functions broadening with decreasing scattering energy as in extended scattering media. The angles δ between the central directions of these radiation fields and the axis of the scintillator were taken to be 22.5, 45, 67.5 and 90°. The results are compared with efficiency and cross section in Gaussian distribution fields with δ = 0° and in isotropic radiation fields from the article mentioned above. (auth)

38289 CO-ORDINATE TRANSFER SYSTEM FOR THE PHO GAMMA III NUCLEAR CHICAGO GAMMA CAMERA. McCready, V. Ralph; Newbery, S. P. (Royal Cancer Hospital and Royal Marsden Hospital, Sutton, Eng.). Brit. J. Radiol., 42: 470-3 (June 1969).

The Pho Gamma III Nuclear Chicago gamma camera is well established as a reliable instrument for visualizing organs and tissues labeled with radioactive substances. However, in routine clinical use, a disadvantage of the instrument in comparison with the moving detector rectilinear scanner is the lack of an accurate method of transferring anatomical landmarks to the gamma camera scintigram. Radioactive point sources can be used as anatomical markers but this technique results in an ill-defined area of brightness, which may be confused with radioactive areas in the organ under examination. In addition, it is not possible to transfer continuous lines, such as the costal margin. The co-ordinate transfer system described is designed to use the display oscilloscope beam to draw lines, or a cross, on the Polaroid film recording the scintigram in the correct anatomical position in relation to the crystal surface. The necessary equipment forms an ancillary unit which can be removed completely in a few seconds, or moved to one side to permit changing of collimators. Its use does not impair the normal circuit operation of the camera. It is so connected that the rotation of the image of the oscilloscope screen, by the XY/YX switch, also alters the reference points of the transfer system. (auth)

38290 COLLIMATOR DESIGN FOR IMPROVING THE LATERAL UNIFORMITY OF RESPONSE IN A SCANNING DESIGN OF WHOLE-BODY COUNTER. Warner, G. T. (Radcliffe Infirmary, Oxford). Brit. J. Radiol., 42: 469-70(June 1969).

An improved collimator design is described for use on a shadow-shield whole-body counter. The collimator provides a detection region in the mid-plane which is shaped as the section through a concave lens, that is with the longitudinal dimension increasing with displacement from the center line of a couch on which the patient is lying. (B.G.D.)

38291 A DEVICE FOR DETECTING URANIUM IN THE ATMOSPHERE. Lafaille, Claude (to Commissariat a l'Energie Atomique). British Patent 1,159,781. July 30, 1969. Priority date July 30, 1965, France.

A device for monitoring the uranium content in the atmosphere is described. The device includes a means for sucking in air from the atmosphere and delivering it to a filter, a means for moving the filter relative to the suction direction exposing different parts of the filter to the air sucked in, and a means for detection and measurement of the radioactivity deposited on the filter. (B.G.D.)

38292 RADIONUCLIDE DIAGNOSTICS BY MEANS OF A SCINTILLATION CAMERA AND COMPUTER METHODS. Winkler, C. (Univ., Bonn). Kerntechnik, 11: 328-32(June 1969). (In German and English).

The principles of scintigraphy with a stationary detector are briefly discussed. Then a system of quantitative scintigraphy is described in which the scintigraphic information obtained with an Anger camera is transmitted via analog/digital converters to the core memory of a 4096-channel analyzer and from there, on line, to a digital computer (Siemens DVA 305). The diagnostic results obtained with this recently developed system are discussed on the basis of examples from clinical practice. (auth)

38293 OPTIMIZATION OF SCINTILLATION CAMERA WITH FULL-SIZE READOUT ON X-RAY FILMS. Alvi, Z. M. (Kaiser Foundation Hospitals, Los Angeles). Health Phys., 17: 483-7 (Sept. 1969).

The image display of a scintillation camera was enlarged through a specially designed optical system directly recording on 11 × 14 in. x-ray blue-brand film. A Weston light meter was used at fixed distance to monitor transmitted light through the developed films when placed on an x-ray film viewer. Absorbed homogeneous radioactivity was simulated by filling a lucite cylinder $\frac{1}{2}$ in. thick and 12 in. diameter with water containing 4 mCi of ^{114m}In. Several films were taken at various intensity and preset counts settings, and film transmittance was measured. Various relationships became apparent when studied through the graphs given. Diagnostic judgement of full size film images can thus be based on more quantitative considerations for the localization of neoplastic lesions. (auth) (UK)

38294 TRACK-ETCH NEUTRON RADIOGRAPHY. Alter, Henry Ward (to General Electric Co.). U. S. Patent 3,457,408. Filed Dec. 12, 1966.

A method and apparatus for neutron radiography using track-etch techniques are disclosed. Typically, in this system an object is placed between a neutron source and a composite consisting of a sheet of detector material and a conversion material. Neutrons passing through the object with variable attenuation, cause the emission of charged particles by the conversion material which impinge on and form damage tracks in the detector sheet. The damage tracks are enlarged by etching. Where neutron density is sufficient, a visible variable density, light scattering, radiographic image of the object results. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 39859, 39909, and 39940.

38295 (AD-681454) RESEARCH IN THE DESIGN, DEVELOPMENT, AND CONSTRUCTION OF NONMAGNETIC SENSORS FOR MAGNETIC FIELD-CHARGED PARTICLE CORRELATION STUDIES. Final Report, November 1963-June 1968. Sellers, Bach; Hanser, Frederick A.; Hunerwadel, Jean Luc (Panametrics, Inc., Waltham, Mass.). Oct. 1968. Contract AF19(628)-3896. 54p. (AFCRL-68-585). CFSTI.

The results reported can be divided into three areas: (1) Design, construction and flight on a Javelin rocket of a first generation charged particle detection system, for (a) protons with energy between 0.45 MeV and 1.7 MeV, and (b) electrons between 25 keV and 200 keV. (2) Design and construction of a magnetometer range expander. (3) Design and construction for a Nīros rocket of a second generation charged particle detection system for (a) protons between 0.4 and 3 MeV, (b) electrons from less than 0.5 keV to 15 keV and (c) electrons from 15 keV to 200 keV. Using the system described in (1) above, the differential spectrum of electrons with E > 25 keV and the integral intensity of protons with 0.45 MeV < E < 1.7 MeV have been measured with a rocket fired into a weak aurora at Fort Churchill, Canada. The electron spectrum was observed to become softer during the flight. A correlation apparently exists between peaks in the electron and proton intensities. Broad peaks in the particle intensity correlate with broad dips in the x component of a ground based magnetometer. The magnetometer record appears to be composed of a broad and symmetrical "slow" component, and a narrow fast component occurring near the start of the slower component. The measured electron spectra indicate that the fast component was a hard electron precipitation while the slow component resulted from a soft electron precipitation. Measurements with a 30 MHz riometer correlate well with the magnetometer record. (auth) (USGRDR)

38296 (AERE-R-6083) GAMMA-RAY SPECTRA OF LARGE VOLUME AQUEOUS SOURCES. Slade, J. E. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). June 1969. 20p. Dep. CFSTI (U.S. Sales Only). UK 3s. 6d.

The spectra from a small liquid source of ^{137}Cs suspended in water and detected by a NaI(Tl) scintillation detector were obtained at different source positions in a plane through the axis of symmetry of the detector. Isopleths of photofraction and photopeak detection efficiency were established. The same parameters were also measured for different photon energies at points along the axis of symmetry. From these measurements spectra from large volume sources of given dimensions may be predicted. The results were used to estimate the usefulness of gamma-ray spectrometry as a means of estimating the attenuation corrections to be applied in tracer experiments where the active tracer may be buried under inactive layers. (auth) (UK)

38297 (IN-1294) TIME OF FLIGHT INTERFACE. Morgan, G. B. (Idaho Nuclear Corp., Idaho Falls). June 1969. Contract AT(10-1)-1230. 39p. Dep. CFSTI.

The time-of-flight interface described in this report allows the velocity selector and high pressure experiments to be run under computer control. There are two main sections which compose the interface: (1) the program controlled portion in the ToF remote chassis; (2) the direct memory access logic located in the ToF common logic. The unit is capable of collecting data at the average rate of the DMA channel or in bursts of up to 5 events within 1 μsec without losing any events. The dead time for this unit is $\leq$200 ns. (auth)

38298 (RISO-195) A $4\pi\beta$-SPECTROMETER WITH Li-Si COUNTERS. Andersen, Verner (Danish Atomic Energy Commission, Risoe. Research Establishment). March 1969. 92p. Dep.

A 4π β spectrometer is described. It is provided with solid-state detectors placed in a magnetic field from a superconducting magnet. The resolution is 0.8% at 1 MeV. The instrument was used to measure conversion coefficients of different gamma transitions in ^{198}Au, ^{207}Bi, and ^{203}Hg. Furthermore, the instrument was used for measuring the beta shape of ^{32}P, ^{198}Au, and ^{203}Hg. (auth)

38299 (UCRL-18514) HIGH-ENERGY NEUTRON SPECTROSCOPY WITH ACTIVATION DETECTORS, INCORPORATING NEW METHODS FOR THE ANALYSIS OF Ge(Li) GAMMA-RAY SPECTRA AND THE SOLUTION OF FREDHOLM INTEGRAL EQUATIONS. Routti, Jorma Tapio (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1969. Contract W-7405-eng-48. 155p. Dep. CFSTI.

Thesis.

The determination of high-energy neutron spectrum using activation detectors has been studied and developments and extensions in methodology and techniques are reported. The use of high-resolution gamma spectroscopy with Ge(Li) detector systems has been incorporated to the measurement of induced activities. A method for the automatic analysis by computer of semiconductor gamma-ray spectra is described. The application of this method which is based upon the study of photopeaks in the spectra, and the associated computer program is discussed in terms of general gamma spectroscopy. The detector systems considered include conventional threshold detectors, Bonner spheres, and recoil spectroscopy with emulsions. Preliminary studies are also made of the use of high-threshold spallation reactions by employing semiconductor gamma spectroscopy in the measurements and a mathematical model for the evaluation of the cross sections. In the determination of the neutron spectrum from measured activities two numerical methods for the solution of the first order Fredholm integral equation are described. A generalized least-squares technique with matrix inversion and an iterative least-squares method with nonnegative solution are discussed, both of which allow the use of physical a priori information of the solution. The performance of these methods and the associated computer programs with different detector systems is discussed. The techniques described are applied to the analysis of measurements made with activation detectors to determine neutron spectra in the shields of high-energy particle accelerators. (auth)

38300 (UCRL-71676) NEUTRON-CAPTURE GAMMA-RAY STUDIES OF CALCIUM ISOTOPES WITH A Ge(Li)-Ge(Li)-NaI(Tl) COINCIDENCE SPECTROMETER SYSTEM. White, D. H.; Birkett, R. E. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 28, 1969. 28p. (CONF-690802-1). Dep. CFSTI.

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden.

A three-parameter spectrometer system is described, consisting of two Ge(Li)/NaI(Tl) γ-ray spectrometers, one designed for high-energy and one for low-energy neutron-capture γ-rays. These systems may be operated in various modes, both singly and in coincidence. Data were taken with certain calcium isotopes, and the methods of the data analysis are given. A method is described to show how tentative transitions are fit to the proposed level scheme by a linear least-squares program. Results are presented for ^{44}Ca. (auth)

38301 SCINTILLATION METHOD OF SPECTROMETRY OF SMALL QUANTITIES OF RADIOACTIVE ELEMENTS IN LARGE-VOLUME SAMPLES. Fedorov, G. A.; Konstantinov, I. E.; Lukanin, V. S. (Moscow Engineering-Physics Inst.). Med. Radiol., 14: 54-8(July 1969). (In Russian).

The characteristics of an 8-crystal scintillation gamma-spectrometer are described. Methodological problems of employing the spectrometer for investigating the pollution of the external environment are discussed. The spectrometer may be used for operative control over the content of low levels of radioactivity in foodstuffs and agricultural products. (auth)

38302 A COMPUTER ASSISTED QUALITATIVE ANALYSIS OF γ-RAY SPECTRA. Adams, F.; Dams, R. (Ghent Univ.). Radiochem. Radioanal. Lett., 1: 163-75(July 1969).

A tabulation of about 2000 precise γ-ray energies of about 250 isotopes formed through neutron activation was used for the computer assisted identification of γ-emitters in complex γ spectra. The identification consists in the calculation of the γ-ray energies from the peak maximum position by taking into account deviation from linearity of the spectrometer. Successive comparisons of these energies with the energies of the tabulation then allows an identification. (auth)

38303 OSNOVY GAMMA-SPEKTROMETRII PRIRODNYKH SRED. TEORIYA METODA GAMMA-SPEKTROMETRII I GEOLOGO-GEOFIZICHESKIE PRILOZHENIYA. (Principles of Gamma Spectrometry of Natural Resources. Theory of Gamma Spectrometry and Its Geological-Geophysical Applications). Kogan, R. M.; Nazarov, I. M.; Fridman, Sh. D. Moscow, Atomizdat, 1969. 468p.

Theoretical and experimental data are given on γ-spectrometry and its uses in studying natural environment and resources. Gamma-field structure under natural conditions, field fluctuations, parameters of absorption media according to γ ray spectra in the laboratory, and elevation and airplane measurements are discussed. Also, applications of γ-spectrometry under specific conditions, studies of radioactivity of the soil and desert, concentration and migration of uranium, thorium, and potassium in the formations, use of γ spectrometry in exploration of natural resources, in hydrology, and in determination of global fission contamination from nuclear explosions are studied. (R.V.J.)

38304 STABILIZATION OF AMPLIFICATION COEFFICIENT OF SCINTILLATION NEUTRON SPECTROMETERS. Brovchenko, V. G.; Kondratev, L. G.; Lebedeva, N. S.; Morozov, V. M. (Inst. of Atomic Energy, Moscow). Prib. Tekh. Eksp., No. 1, 55-7 (Jan.-Feb. 1969). (In Russian).

A simple method was described for stabilization of the transmission coefficient with the possibility of attaining an accuracy of better than 1%. (tr-auth)

38305 DIRECT SPECTROSCOPIC MEASUREMENTS USING NEUTRONS OR CHARGED-PARTICLE BEAMS. Balanda, Andrzej (Jagellonian Univ., Krakow). Postepy Fiz., 20: 169-80(1969). (In Polish).

Beta and gamma ray spectrometers working on the beam of charged particles or neutrons are presented. As an example the internal conversion electron spectrum coming from nuclear reaction $^{54}Cr(p,n)^{54}Mn$ is given. (auth)

38306 A MAGNETIC β SPECTROMETER FOR THE STUDY OF SHORT-LIVED ACTIVITIES PRODUCED IN NUCLEAR REACTIONS. Rakivenko, Yu. M.; Klyucharev, O. P.; Yatsenko, H. I.; Romanli, I. A.; Skakun, E. O. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 13: 475-9(1968). (In Russian).

A description is presented of a method for investigating short-lived isomers by means of a magnetic β spectrometer of the ketron type in conjunction with a pulsed proton accelerator. Isomeric levels are excited in nuclear reactions produced by protons in a target located at a focus of the spectrometer. Magnetic analysis of internal conversion electrons is carried out in the intervals between accelerator bursts. Measurements of conversion-electron spectra are given for delayed transitions in ^{90}Nb, ^{148}Eu, and ^{180}W. (JPRS)

38307 NEUTRON SPECTROMETRY AND DOSIMETRY IN THE SUBCORE FACILITY OF A SWIMMING POOL REACTOR. Chadwick, K. H.; Oosterheert, W. F. (EURATOM-ITAL, Wageningen, Netherlands). Atompraxis, 15: 178-80(May-June 1969).

The neutron spectrum in the irradiation room of the Euratom-Ital Association Biological Agricultural Reactor Netherlands (BARN) has been measured using ^{6}Li sandwich detectors from 300 keV upwards. From the spectrum the kerma in soft muscle was calculated and compared with the dose measured with a tissue equivalent ion chamber. Monoenergetic neutrons of 3.2 MeV were used to calibrate the spectrometer system. The effect of pulse pile-up on the spectrum shape is discussed. (auth)

38308 NEUTRON CAPTURE GAMMA RAY FACILITY USING AN ELECTRON LINEAR ACCELERATOR. Orphan, V. J.; Hoot, C. G.; Carlson, A. D.; John, Joseph; Beyster, J. R. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Instrum. Methods, 72: 254-68(1969).

A versatile facility for the study of resonance neutron capture gamma-ray spectra with high energy resolution is described. An electron linear accelerator is used to provide a pulsed beam of neutrons. Gamma-ray spectra are measured using a Ge(Li)-NaI(Tl) spectrometer. The gamma-ray pulse height and the neutron time-of-flight information are stored using an on-line computer. The salient features of the capture facility are described and spectra resulting from the capture of neutrons in natural tungsten are displayed. (auth)

38309 MAGNETIC ANALYSIS OF COMPTON ELECTRONS PRODUCED BY THIN-TARGET BREMSSTRAHLUNG OF ELECTRONS AT 3.5 MeV. Bourgoignie, R. R. (Rijksuniversiteit, Ghent). Nucl. Instrum. Methods, 72: 277-84(1969).

A magnetic Compton electron spectrometer, to be used in the energy range 0.2 to 4.0 MeV, is described. The instrument is calibrated and used to measure thin-target bremsstrahlung of aluminum and gold foils, the incident electron beam having an energy of 3.5 MeV. Experimental results are compared to theory and existing results. (auth)

38310 INVESTIGATION OF SUPERFICIAL STATES OF SURFACE-BARRIER pn SILICON JUNCTIONS INTENDED FOR X-RAY SPECTROMETRY. Peyre-Lavigne, A. (Univ., Toulouse); Blanc, D.; Pichevar, M.; Petel, M.; Soudain, G. Nucl. Instrum. Methods, 72: 340-6(1969). (In French).

The use of impedance bridges enables one to obtain the capacitance of the silicium-oxide layer, as well as the density of the superficial charges. One deduces the relationship which links the applied voltage to the space charge reduced potential. The measurement of the diodes response, when made to undergo train impulses, enables one to obtain their relaxation time, whose variations with temperature and inverse polarization voltage one can study. From this, one can deduce the density and the location of the superficial centers in relation to the conduction band. The average capacitance associated with the relaxation time has a value close to that obtained using the impedance bridge. Finally, we have determined the resistance of the ohmic contact which is involved in the pulse rise time. This information system enables one to produce more stable detectors and in particular, to produce junctions working on a preavalanche regime. (auth)

38311 LOW-BACKGROUND SPECTROMETER FOR FAST-NEUTRONS. Scherber, W.; Hofmann, A. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods, 72: 301-6(1969). (In German).

A counter telescope for fast neutron spectroscopy is described. For the telescope, consisting of three CO_2 flow counters and a silicon detector, an efficiency of 1.1×10^{-6} counts per incident neutron is obtained at $E_n = 14$ MeV, the background sensitivity being less than 3%. The neutron energy spectra are obtained from the measured pulse height distributions by a computer program, which takes into account radiator thickness, aperture angle, (n,p) cross section and energy loss of the recoil protons in the telescope. (auth)

High Energy Physics Instrumentation

Refer also to abstract 39619.

38312 (BNL-13828) ELECTRON ATTACHMENT OF CCl_4 IN He USING PULSED SPARK CHAMBER EFFICIENCY AS A SENSITIVE ELECTRON INDICATOR. Fischer, Joachim; Shibata, Shinkichi (Brookhaven National Lab., Upton, N. Y.). [nd]. 4p. (CONF-690803-13). Dep. CFSTI.

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

The total electron attachment coefficient of CCl_4 in He, at normal pressure and 25°C, was determined as a function of electron energy, using a technique of pulsed spark chamber efficiency as a sensitive electron indicator. The attachment coefficient diminishes from 10^4 attach./cm · torr at 0.04 eV to only 77 at 4 eV. A fine structure peak in attachments per sec. is apparent around 0.05 eV. (auth)

38313 (LNF-69/16) MEASURE OF THE EFFICIENCY OF A SPARK CHAMBER AS FUNCTION OF THE SPECIFIC IONIZATION OF A PARTICLE. Note No. 436. Grilli, M.; Spiliantini, P.; Visentin, R. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Mar. 7, 1969. 13p. (In Italian). Dep.

For the study of the (e^+e^-) annihilations into two charged bosons a spark chamber with thin plates was designed. The results of the calibrations made on this spark chamber with particles at the minimum of ionization and with particles of diverse specific ionizations are reported. The results of the calibrations of the chamber with particles at the minimum are standard. Those with particles with diverse specific ionizations seem to indicate a difference in efficiency in the presence of diffuse background. This effect can be used for the partial discrimination between particles with $I/I_0 \simeq 1$ and $I/I_0 \geq 7$. (J.S.R.)

38314 (NP-tr-1810) INCREASING THE DISCHARGE TIME IN A SPARK CHAMBER TO 10 TO 100 MSEC. Akimov, Yu. K.; Protsenko, V. N.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by R. R. Inston (Atomic Energy Research Establishment, Harwell, Eng.), from report JINR-R13-3064. 9p. Dep.

A method to increase the discharge duration in a spark chamber for the time up to 10–100 msec is described and investigation results of such discharge conduct in time are given. (auth)

38315 PHOTOGRAPHIC SYSTEM OF ONE-METER BUBBLE CHAMBER PK-300. Aleksanyan, A. S.; Arutyunyan, N. Kh.; Bekker, B. I.; Veremeev, M. M.; Levonyan, E. Ts.; Pikhtelev, R. N. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 434-6(1968). (In Russian).

The optical characteristics of the stereophotogrammetrical camera KS-III, the description of the photoregister and the photographic scheme of the one-meter bubble chamber are given. The objective distortion caused by the refracting medium is less than 0.01 mm. The photographs are made on two 80 mm perforated aerofilms. Each frame has its number; the film number and the frame number code are marked on the side. The frame number code is given by two SHI-50. (auth)

38316 GYROMAGNETIC COEFFICIENT OF THE PROTON. Vigoureux, P. (National Physical Lab., Teddington, Eng.). Rev. Gen. Elec., 78: 269-74(Mar. 1969). (In French).

The design of an apparatus for the measurement of the gyromagnetic coefficient of the proton is described; details of original design and of practical construction are given for components except the coils which produce the known magnetic field. The measurement of variations in the terrestrial magnetic field near the apparatus is outlined. A control method by which the terrestrial magnetic field variations may be reduced considerably is described. The method is based on free precession in a weak field; a calculable induction is produced by coils of known size. Precession of the protons in water in the center of the apparatus induces an emf in the detector coil whose frequency is measured by an accurate frequency meter. The first experiments in 1961 used a field only 25 times larger than the terrestrial magnetic field, and specially designed Helmholtz coils were used to counteract the terrestrial field. (BBB)

38317 RADIATION DETECTORS. Stuckenberg, Hans-Joachim (Deutsches Elektronen-Synchrotron, Hamburg). pp 269-88 of Atome, Kerne, Elementarteilchen. Suessmann, Georg; Fiebiger, Nikolaus (eds.). Frankfurt am Main, Umschau Verlag, 1968. (In German).

The characteristics and operation of ionization chambers, proportional counters, scintillation counters, neutron counters, Cherenkov counters, and semiconductor counters are briefly described. The construction, characteristics and operation of the orbit detectors cloud and bubble chambers, photographic emulsions, and spark chambers are also discussed. (J.S.R.)

38318 NUCLEAR DATA PROCESSING. Stuckenberg, Hans-Joachim (Deutsches Elektronen-Synchrotron, Hamburg). pp 289-300 of Atome, Kerne, Elementarteilchen. Suessmann, Georg; Fiebiger, Nikolaus (eds.). Frankfurt am Main, Umschau Verlag, 1968. (In German).

The processing of signals from radiation detectors occurs through the logical scheme: data collection, digitalization, data reduction, data transport, and data processing. Energy and time measurement procedures are outlined. Data collection from orbit detectors is described. Computer-conducted experiments are briefly considered. (J.S.R.)

38319 INTERFERENCE PHENOMENA IN RECORDING OF DECAYING PARTICLE PAIRS. Lyuboshits, V. L.; Podgoretskii, M. I. (Joint Inst. of Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 57: 175-82(July 1969). (In Russian).

The ideas developed previously are applied to an analysis of interference phenomena during registration of pairs of nonidentical particle pairs. General formulas are derived for the probability of recording decaying particle pairs and resonances in correlation experiments. It is demonstrated that interference depending on the proper time of flight of the particles and related to nonorthogonality of the internal wave functions occurs during recording by a single detector of the decay products of two particles with identical spins and other conservable quantum numbers. If the particles have different conservable quantum numbers their internal functions will be orthogonal to each other and interference during registration of such particles by a single detector is always absent. (auth)

38320 MISSING MASS AND SPARK CHAMBERS. McLeod, D. (Univ. of Illinois, Chicago). Nucl. Instrum. Methods, 72: 333-9 (1969).

A summary of some missing mass techniques for triggering spark chambers or recording data with counters in high energy physics experiments is presented. Their limitations are discussed. New methods for use with systems including magnets are shown. (auth)

38321 DETERMINATION OF THE INITIAL APPROXIMATION FOR THE KINEMATICAL PARAMETERS OF A CHARGED PARTICLE. Makarenko, G. I.; Moroz, V. I.; Saitov, I. S.; Stelmakh, A. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods, 72: 347-50(1969).

In order to obtain the kinematical parameters of a charged particle, which moves with ionization losses in a medium placed in a nonuniform magnetic field, it is necessary to have their initial estimates as precise as possible. Usually one approximates the measured points of a track by a parabola and then obtains with some accuracy the momentum and angles considering a constant value of the magnetic field and a constant value of the ionization losses along the track. It is shown that one can obtain more precise values of these kinematical parameters using the same parabola. In order to check the accuracy of the method the kinematical parameters have been determined for artificial tracks in a propane bubble chamber with a 20% nonuniformity of the magnetic field. The results are included. (auth)

Radiation Dosimeters

Refer also to abstracts 38261 and 39011.

38322 (BNWL-1080) RESPONSE OF SELECTED THERMOLUMINESCENT MATERIALS TO FAST NEUTRON EXPOSURES. Endres, G. W. R.; Kocher, L. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1969. Contract AT(45-1)-1830. 17p. Dep. CFSTI.

This current study, an extension of the earlier work, is directed toward measuring the fast neutron response of most of the common TLD materials when placed on a polyethylene phantom to simulate actual personnel dosimetry conditions. The TLD materials used were LiF(TLD-100), LiF(TLD-600), LiF(TLD-700), $Li_2B_4O_7$, and CaF_2 in either pressed block or teflon matrix form. Exposures to fast neutrons were conducted using a Van de Graaff positive ion accelerator to produce monoenergetic neutrons in the energy range 0.2 to 1.0 MeV from the $T(p,n)^3He$ reactions. Exposures were made in air with low-scatter conditions. A phantom was placed behind the TLD material, and cadmium and boron-10 shields surrounded it for the purpose of evaluating the contribution of backscattered neutrons. The standard used for dose measurement was the Hanford precision long-counter. LiF(TLD-600) presently appears to hold the greatest promise for neutron personnel dosimetry. Though most of the TLD-600 response is due to thermalized and backscattered neutrons, design of a proper filter system to provide an accurate measure of fast neutron tissue-absorbed dose is considered possible. The minimum detection limit for neutrons from a PuF_4 neutron source is less than 5 mrad using current readout equipment. LiF(TLD-100) and $Li_2B_4O_7$ also show a significant response to fast neutrons when placed on a phantom. Both, however, are less sensitive than the TLD-600 material. (auth)

38323 (COO-1105-153) A SIMPLE TL DETECTOR USING A PHOTORESISTOR. Podgorsak, E.; Pearson, D. W.; Cameron, J. R. (Wisconsin Univ., Madison. Dept. of Physics). July 15, 1969. Contract AT(11-1)-1105. 5p. Dep. CFSTI.

A brief description of an inexpensive reader for thermoluminescent dosimeters is given. The system consists of a cadmium sulfide photoresistor as the light sensing element and an operational amplifier for amplification of the signal. (W.H.K.)

38324 (DUN-5936) CIRCUIT CONCEPTS CONSIDERED IN DEVELOPMENT OF A POCKET DOSIMETER. Erickson, G. L. (Douglas United Nuclear, Inc., Richland, Wash.). June 20, 1969. Contract AT(45-1)-1857. 8p. Dep. CFSTI.

Various concepts of dose integration circuits in the development of an integrating-type pocket dosimeter using a Geiger-Mueller tube are presented. These include capacitor integration, mechanical integration, and electro-chemical integration. (W.H.K.)

38325 (EIR-152) CONTROL OF PERSONNEL NEUTRON DOSES BY COUNTING OF FISSION-FRAGMENT TRACKS IN CERTAIN PLASTICS. Pretre, S. B. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Apr. 1969. 18p. (In French). (CONF-690523-1). Dep.

From International Meeting for the Study of Charged Particle Tracks in Solid and Thin Application, Clermont-Ferrand, France.

A neutron dosimeter is described which is now worn by the personnel at the nuclear center of Wirenlingen and which permits the measurement of routine doses as well as possible accidental doses. It contains two detectors each composed of a disk of fissile metal adjacent to a plastic (lexan) disk. The metal is one part Th-232 for the detection of fast neutrons and the other part an Al-U-235 alloy for the detection of thermal neutrons. Certain fission fragments penetrate the plastic disks and leave tracks there which are revealed in a solution of KOH then counted at the microscope. The neutron doses are directly proportional to the track densities. (tr-auth)

38326 (TID-25161) PRE-IRRADIATION ANNEALING AND LOW TEMPERATURE PEAKS IN LiF. Zimmerman, David; Cameron, John R. (Wisconsin Univ., Madison). [1964]. Contract AT(11-1)-1105. 6p. Dep. CFSTI.

Results of a series of experiments to determine the effects of preannealing on lithium fluoride thermoluminescent dosimeters and to examine other factors which might affect the size of low-temperature peaks are briefly discussed. Effects of variable cooling rates, pre-irradiation annealing, and dielectric loss measurements are considered. (W.H.K.)

38327 SCINTILLATION-SEMICONDUCTIVITY DOSIMETER FOR γ RADIATION. Sugier, H.; Nowakowski, J. (Technical Univ., Lodz, Poland). Radiochem. Radioanal. Lett., 1: 177-80 (July 1969).

A brief description of the design and performance of a scintillation detector with a semiconductor photodetector for gamma dosimetry is presented. (W.H.K.)

38328 EXPERIENCE IN THE UTILIZATION OF DPM-1 DOSIMETER IN THE CLINICAL DOSIMETRY OF ^{60}Co GAMMA-RADIATION. Skoropad, Yu. D.; Balandina, R. K. (Inst. of Medical Radiology, Moscow). Med. Radiol., 14: No. 7, 59-64 (July 1969). (In Russian).

Data on the employment of radiophotoluminescent DPM-1 dosimeters in phantom measurements are presented, and the use of such detectors subjected to an indirect scaling as "witnesses" of the dose in ^{60}Co gamma therapy is discussed. (auth)

38329 IRRADIATION TEMPERATURE EFFECTS OF CLEAR PERSPEX DOSIMETERS. Bolton, J. H. (Australian Atomic Energy Commission Research Establishment, Sutherland, New South Wales). Int. J. Appl. Radiat. Isotop., 20: 605-8(Aug. 1969).

The effect of temperature during irradiation on the radiation induced O.D. (optical density) of clear Perspex at 305 mμ is described. In the range 8-60°C the extinction temperature coefficient was 3.7×10^{-4}/°C. The wavelength 305 mμ was chosen using the arguments presented by the U.K. Panel on Gamma and Electron Irradiation. The fade of O.D. was not influenced by irradiation temperature, but clearly dependent on dosimeter thickness. (auth)

38330 THERMOLUMINESCENT RESPONSE OF LITHIUM FLUORIDE TO RADIATIONS WITH DIFFERENT LET. Suntharalingam, N.; Cameron, J. R. (Univ. of Wisconsin, Madison). Phys. Med. Biol., 14: 397-410(July 1969).

The supralinear TL response of LiF (TLD-100) was investigated for radiations with different LET. High energy electrons from 6 to 33 MeV, 4.4 MeV deuterons, thermal neutrons, ^{137}Cs γ-rays, soft x-radiation and monoenergetic electrons from 50 to 400 keV were used. The high energy electrons and ^{137}Cs γ-rays showed an identical response. The higher LET radiations caused less supralinearity, and no supralinearity was seen with deuteron irradiations. The sensitivity factors, a measure of the radiation-induced increase in sensitivity, showed a pronounced dependence on the quality or LET of both the sensitizing and the test radiations. Low

LET radiations gave a high sensitivity factor at doses greater than 10^4 rads; as the LET increased the sensitivity factor decreased. There are four different radiation-quality dependent effects in the thermoluminescence of lithium fluoride: (1) the low energy increase in response due to the increase in photoelectric cross section; (2) increase in efficiency at low doses with increase in LET; (3) decrease in supralinearity with increase in LET; (4) decrease in the response of sensitized phosphor with increase in LET. A physical model for the supralinearity is proposed. The changes in sensitivity are accounted for by the elimination of competing mechanisms during irradiation. (auth) (UK)

38331 CHEMICAL DOSIMETER. Oster, G. (to U. S. Atomic Energy Commission). U. S. Patent 3,461,288. Aug. 12, 1969.

A radiation dosimeter comprised of a film composed of a mixture of powdered polyvinyl chloride and 1, 2, 7, 8 dibenzanthracene fused together at high pressure while being heated to about 150°C is described. (AEC)

38332 USE OF CLEAR PMMA AS A DOSIMETER FOR IRRADIATION STUDIES IN THE RANGE 10 krad TO 10 Mrad. Chadwick, K. H. (EURATOM–ITAL, Wageningen, Netherlands). Atompraxis, 15: 181-4(May-June 1969).

The optical density–dose relationship of clear polymethylmethacrylate (PMMA) was investigated. A pretreatment of the PMMA is described whereby the useful dose range is extended down to 10 krads. The effect of various environmental factors on the radiation induced optical density is considered and a series of precautionary measures necessary for accurate and reproducible dosimetry is mentioned. (auth)

38333 DOSIMETRY BY THERMOLUMINESCENCE. van Wallendael, S. (MBLE, Brussels). Atompraxis, 15: 168(May-June 1969). (In French).

The intensive use made of radioactive materials involves the problem of surveyance of people exposed to radiation hazards. In order to comply with respective laws which have been passed in many countries, dosimetry equipment based on the principle of thermoluminescence has been developed and manufactured by an important Belgian firm in electronics. The advantages of this principle are briefly summarized. (auth)

38334 SOME EXPERIMENTS AND A PRACTICAL METHOD ON DOSIMETER GLASS WASHING PROCESS. Yokota, Ryosuke (Tokyo Shibaura Electric Co., Kawasaki, Japan); Muto, Yuhei; Nakajima, Saburo; Sasanuma, Yoshio. J. Nucl. Sci. Technol. (Tokyo), 6: 413-14(July 1969).

Various washing processes for silver-activated phosphate glass dosimeters are evaluated. (W.H.K.)

38335 RECORDING DOSIMETER FOR CONTINUOUS MONITORING OF NURSES IN RADIUM WARDS. Davison, M.; Reekie, D. (Western Regional Hospital Board, Glasgow). Brit. J. Radiol., 42: 467-8(June 1969).

The pocket dosimeter uses a miniature MX 163 Geiger–Mueller tube driving a small speaker unit. The output pulses are tapped off and connected into the microphone input of a small fm transmitter. The signals are picked up by a dipole aerial and vhf receiver, pass through a decade counter to reduce sensitivity, and then into a digital printout unit. (W.H.K.)

38336 IN-BODY DOSIMETRY WITH THE AID OF LiF THERMOLUMINESCENCE AFTER INCORPORATION OF ^{137}Cs IN THE RAT. Steinbach, K. H. (Heiligenberg Institut, Ger.). Kerntechnik, 11: 318-21(June 1969). (In German and English).

The calibration of miniature LiF dosimeters with the aid of a solution of ^{137}Cs in a spherical geometric configuration is described. In subsequent experiments on male rats the absorbed dose in the liver following intravenous injection of ^{137}Cs was determined in function of the incorporation time. After injection of a total activity of 50 μCi per animal, the absorbed dose in the liver increased from 5.0 ± 0.3) Rad on the 2nd day after the injection to (27.4 ± 1.0) Rad on the 32nd day. The expected linear relationship between the absorbed dose rate and the activity concentration in the liver was confirmed. (auth)

Radiometric Instruments

Refer also to abstracts 38083, 38182, 38266, and 39920.

38337 PARTICLE SIZE ANALYSIS. Kalshoven, Johan (to EURATOM). British Patent 1,158,338. July 16, 1969. Priority date Oct. 12, 1965, Netherlands.

An apparatus is described which facilitates the measurement of particle size distribution of particles dispersed in a fluid. The apparatus consists of an x-ray source, radiation detector and a tank in which the particle-dispersed fluid is contained. (B.G.D.)

38338 METHOD AND APPARATUS FOR MEASURING VOID FRACTION OF HYDROGENOUS FLUIDS. Jackson, Charles N. Jr.; Spear, Ward G. (to U. S. Atomic Energy Commission). U. S. Patent 3,461,286. Aug. 12, 1969.

A method and apparatus for measuring the void fraction of hydrogenous fluids, such as boiling water, using absorption and moderation effects of the mixture are described. A high-intensity beam of fast neutrons is directed through the hydrogenous fluid and the intensity of the thermal neutrons obtained by scattering from said hydrogenous fluid or by moderating fast neutrons passing completely through the fluid is measured. (AEC)

38339 ADAPTION OF MULTICHANNEL ANALYZERS TO PROCESS CONTROL. Riel, Gordon K. (Naval Ordnance Lab., Silver Spring, Md.). ISA (Instrum. Soc. Amer.) Trans., 8: 16-19(1969).

Multiparameter radioisotope gages can record several variables with one detector and multichannel analyzer. This equipment which may be used for process control with either radioisotope or conventional gages is described. The multichannel analyzer is a step toward direct digital control, but it is more like several hundred indicator controllers. If a block of channels is assigned to each gage, the multichannel analyzer can replace several strip-chart recorders. The normal display would be a straight row of dots across the scope face, so the operator could easily spot an abnormal reading in any one of several hundred gages. Records are printed automatically at selected times, or when desired at the touch of a button. (auth)

38340 HOW TO USE NUCLEAR DENSITY, LEVEL GAUGES. Turner, K. A. Can. Contr. Instrum., 8: 25-8(May 1969).

Radiation sources and arrangements for sensing density and liquid levels are described. Details of source decay amplification required and radiation safety are outlined. Several possible applications are given with suggestions of difficulties likely to be encountered. It is concluded that nuclear gages are capable of sensing and controlling process variations with extremely good sensitivity and long term stability. There are no moving parts and they do not contact process material, thus reducing maintenance. Their outputs make analog or digital control possible. (Canada)

38341 MOVING GAMMA-SOURCE METHOD OF MEASURING SOIL DENSITIES. Lin, K.; Pirie, E.; Taylor, D. (Univ. of Strathclyde, Scotland). Nucl. Instrum. Methods, 72: 325-8(1969).

The conventional type of gamma-ray backscatter density gauge has a characteristic (counting-rate vs density) comprising a portion with a positive slope and a portion with a negative slope, the maximum counting rate being obtained with a specific density ρ_m, which depends on the geometry of the gauge and, in particular, on the source-detector separation d. It is shown that these considerations lead to a different type of density gauge in which d is varied for maximum response. This moving-source type of density gauge possesses a number of advantages, but imposes certain design difficulties. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 38585, 39420, 39862, and 40314.

38342 (AD-679635) DISCUSSION ON A CHAMBER TO MEASURE ION NUMBER DENSITIES UNDER LOW PRESSURE AND SUPERSONIC SPEED. Report No. Scientific-1. Dolezalek, Hans (Adcole Corp., Waltham, Mass.). Feb. 24, 1967. Contract AF19(628)-5963. 51p. (AFCRL-68-199). CFSTI.

The problems of designing a chamber to measure absolutely the ion number densities when moving with supersonic velocity through the atmosphere are briefly discussed. An attempt is made to design such a chamber, matching other already existing chambers in some essential points. A design sketch is given, and the first tests are described. This first attempt towards an absolute ion chamber is made to provide a possibility for wind tunnel calibration of chambers to be flown by rockets. The altitude range considered is from about 30 km to about 80 km in the terrestrial atmosphere. (auth) (USGRDR)

38343 (BNWL-1022) ULTRASONIC THICKNESS MEASUREMENT FOR PRECISION CONTROL OF MACHINE TOOLS. Newman, Dennis R.; Lamb, Lloyd T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1969. Contract AT(45-1)-1830. 23p. Dep. CFSTI.

A prototype ultrasonic micrometer using the pulse interference technique has been developed which gives an accurate, continuous readout. The micrometer has been adapted for control of an electro-spark discharge machine and the system has been used to mill aluminum plates to within ±0.0001 inch of a constant thickness. Physical principles and electronic circuits for the system are described. (auth)

38344 (CEA-R-3647) CONTRIBUTION TO THE STUDY OF TIME-RESOLUTION IN PULSE ELECTRONICS FOR NUCLEAR PHYSICS: PHASE CONTROL CIRCUITS. Cortet, Jean-Paul (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1968. 127p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Orsay, France.

Phase control circuits make it possible to improve quite markedly the time resolution in pulse electronics. They replace a random pulse, of which the time of arrival with respect to a reference zero is being measured, by another pulse whose phase is well determined with respect to that of a clock taken as reference. The time spectrum of the output, delayed, can always be situated inside channels of width ΔT defined by the clock. The time statistics of the events analyzed is always correct even if the transition time for the circuits defining the channels represents a large fraction of ΔT: the coding of the time becomes perfect. The phase control circuits, used in precision chronometry, are widely applied in nuclear physics since the time spectra obtained are representative, indirectly, of certain values which are required to be measured with great accuracy. A description is given of the constitution and operation of phase control circuits, and a chain with automatic analysis and automatic reading, built for testing these circuits. Finally the measurement results are given. (auth)

38345 (CONF-681064-5) REACTOR INSTRUMENTATION. Smith, K. R. E. (Elliott Process Automation Ltd., London (England). Reactor Control Div.). [1968]. 4p. Dep.

From British Nuclear Forum and Deutsches Atomforum Meeting, Frankfurt am Main, Germany.

The monitoring of flux distribution in power reactors for operational purposes and the monitoring of power and its rate of change for trips and alarms are discussed. (UK)

38346 (CONF-690401-, pp 155-72) DESIGN OF A NUCLEAR DATA ACQUISITION SYSTEM. Macdonald, Robert N.

A multi-user nuclear data acquisition system has been designed for the IBM 1800 computer. The system is based on a control unit which allows most standard nuclear instrumentation, such as analog-to-digital converters or scalars, to be plugged directly to the interface with no modifications. By means of a diode pin matrix plugboard, the control unit can be reprogrammed to handle eight different configurations of up to fifteen components while the system is on-line. This can be accomplished without disrupting the experiments in progress. Data transfer takes place via a high speed data channel operating in the cycle steal mode. This minimizes data collection time and permits a higher burst data rate. The programming system (PALS) used is highly interactive, allowing multi-tasking on each of two priority levels, plus a background job. System resources, such as core storage and disk space, are allocated dynamically as they are requested by the user and returned to the system when a user's program exists. If desired, user programs may be written in a special application-oriented language which relieves the experimenter of the necessity of knowing assembler language. Full use of all system facilities is provided at remote locations, thus, permitting operation of the computer from the experiment area rather than the computer room. (auth)

38347 (CONF-690401-, pp 435-50) EFFECTIVE USE OF THE COMPUTER STORAGE HIERARCHY. Jordan, Thomas L.; Worlton, William J. (Los Alamos Scientific Lab., N. Mex.).

Guidelines for the selection of a properly balanced hierarchy of equipment and the proper use of the storage hierarchy are discussed. Also, experience at LASL with extended core storage is described. (W.H.K.)

38348 (CONF-690401-, pp 471-80) DATA MANAGEMENT FOR MULTIACCESS COMPUTATIONAL SYSTEMS. Suich, J. E.; Jensen, J. C.; Honeck, H. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.).

Data and job management for the JOSHUA multiaccess computational system are described. The JOSHUA system at Savannah River Laboratory is intended for application to problems in the management of a nuclear reactor facility. FORTRAN is used. (W.H.K.)

38349 (LA-4175) EPUT MULTIPLEXER CODER DRIVER AND THE EPUT MULTIPLEX DECODER. Fullwood, Ralph R. (Los Alamos Scientific Lab., N. Mex.). May 1, 1969. Contract W-7405-eng-36. 5p. Dep. CFSTI.

The EPUT Multiplexer Coder Driver sequentially measures the events per unit time (EPUT) of a maximum of 10 input channels for a period of 0.1 or 1.0 sec. It displays the count and the channel identification for 1, 2, or 4 sec and serially shifts what had been displayed onto a voice-grade telephone line in a BCD code together with shift bits. This is decoded and displayed at a remote location by the EPUT Multiplex Decoder. It is also capable of fixed-channel operation. (auth)

38350 (LA-4178) PRECISION STAIRCASE CALIBRATOR FOR FIELD USE. Fullwood, R. R. (Los Alamos Scientific Lab., N. Mex.). May 1, 1969. Contract W-7405-eng-36. 8p. Dep. CFSTI.

A linear nine-step staircase calibrator has been constructed for field use capable of +90 V to a 51 Ω load on the top step. The step voltages are obtained by measuring the continuously variable supply voltage and using tables provided in this report. (auth)

38351 (NYO-3906-7) ULTRASONIC THERMOMETRY IN LMFBR SYSTEMS. Seventh Quarterly Progress Report Covering the Period Ending June 1969. Fam, S. S.; Lynnworth, L. C.; Carnevale, E. H. (Panametrics, Inc., Waltham, Mass.). June 1969. Contract AT(30-1)-3906. 10p. Dep. CFSTI.

The progress achieved during the seventh quarter, April-June 1969, is summarized as follows: 1) Attempts were made to use a composite W/Re thermocouple-ultrasonic probe even though the tie-on lines were not at the optimum points for ultrasonic measurements. Signal overlap and interference were again observed at ~3500°F. In addition, the thermocouple emf was observed to fluctuate erratically, indicating poor contact of the tie-ons. From these results it appears that, in order to successfully conduct tests at ORNL, alternative designs need to be considered. 2) Anodized aluminum coils were tested at 500°F for 1030 hours, 800°F for 780 hours, 900°F for 100 hours, and at 1000°F for 230 hours. Coil failures were observed at 800°F and 1000°F, possibly due to gradual diffusion of the parent metal through the anodic layer. A summary of all coil tests to date is presented. (auth)

38352 (RISO-M-873) SEMIANNUAL REPORT FOR THE PERIOD 1st APRIL-30th SEPTEMBER 1968. (Danish Atomic Energy Commission, Risoe. Research Establishment). Mar. 1969. 39p. Dep.

Research and development programs are described including process control and automation, nuclear geophysical methods, and instrumentation. The publications and staff of the Electronics Department are listed. (W.H.K.)

38353 (SLAC-101) TRANSIENTS IN JUNCTION DIODE CIRCUITS. Barna, Arpad (Stanford Linear Accelerator Center, Calif.). Mar. 1969. Contract AT(04-3)-515. 32p. Dep. CFSTI.

Switching properties of junction diodes are analyzed with emphasis on the effects of conductivity modulation resulting in inductive behavior. Transients are computed including conductivity modulation, diffusion capacitance, transition capacitance, and finite generator impedance. (auth)

38354 (UCRL-71520) COMPUTER CONTROLLED DATA ACQUISITION AND ISOTOPIC RATIO MEASUREMENTS IN REAL TIME. Bailey, C. A.; Peterson, R. L.; Siemens, P. D.; Dupzyk, R. J. (California Univ., Livermore. Lawrence Radiation Lab.). June 6, 1969. 5p. (CONF-690523-1). Dep. CFSTI.

From 17th Annual Conference on Mass Spectrometry and Allied Topics, Dallas, Tex.

A computer program written on a 4K PDP-8 for on-line data acquisition from a multistage mass spectrometer is described. This system includes real time data acquisition, display, and data reduction. Data are obtained by pulse counting techniques (20 nanosecond double pulse resolution) with the computer providing multisumming scaling over 256 channels. A keyboard monitor provides the operator with complete control of the system. By typing control characters on the teletype various operations occur, such as: calling for real time data acquisition; storage of data on DECtape (magnetic tape); real time data display (log or linear); finding peaks in the spectrum; calculating atom ratios; or printing data on the teletype. By using program interrupt techniques several of these operations appear to go on at the same time. (auth)

38355 IMPROVEMENTS IN OR RELATING TO OSCILLATION GENERATORS. McIlraith, Arthur Hamilton (to National Research Development Corp.). British Patent 1,158,782. July 16, 1969. Filed May 14, 1965.

Reference is made to oscillation generators of the charged particle transit time type, that is, generators in which oscilla-

tions are produced by virtue of the oscillatory movements of charged particles in an electrostatic field. The object of the invention is to provide improved oscillation generators of this type, wherein very stable charged particle oscillations are obtainable, so that very long time constants and high Q values are readily obtainable. The oscillator comprises a low pressure or vacuum chamber containing an outer electrode which surrounds a multi-electrode system and means for applying an electrostatic potential to the electrode system to give a polarity with respect to the outer electrode opposite in sign to the polarity of the oscillating charged particles. In this way a solely electrostatic field is produced, having a pronounced single saddle configuration in the region of the electrode system, and which produces on charged particles substantially outside the region of the electrode system an electrostatic force having a component directed towards a plane passing between the electrodes, the electrostatic field causing the charged particles in the chamber to follow stable paths of oscillatory movement. Various alternative electrode systems are described. Suitable vacuum or low pressure gauges and pumps are also described, together with associated mass spectrometer apparatus, amplifiers, etc. (UK)

38356 PEAK CURRENT METER. Biggerstaff, J. A.; Nutt, R. (to U. S. Atomic Energy Commission). U. S. Patent 3,464,013. Aug. 26, 1969.

An instrument for the accurate measurement of the average peak current over a given sample time of short, repetitive current pulses such as are obtained at the target of pulsed particle accelerators is described. A bistable biased tunnel diode is connected for sensing the current pulse to be measured. When the tunnel diode senses input current pulses, it would be switched at an increased rate except for the action of the feedback current which adjusts automatically to maintain a nearly constant switching rate. The switching signals from the tunnel diode are shaped into standardized current pulses. This output passes through a pulse rate-to-voltage converter circuit which provides a voltage output proportional to the input pulse current amplitude, and the output of the pulse rate-to-voltage converter is fed back through a voltage-to-current converter to maintain the tunnel diode bias at the correct value for its bistable operation. (AEC)

38357 METHOD FOR GENERATING A BEAM OF IONS WHEREIN THE IONS ARE COMPLETELY POLARIZED. von Ehrenstein, D.; Hess, David C. (to U. S. Atomic Energy Commission). U. S. Patent 3,461,294. Aug. 12, 1969.

A method is described for producing a polarized ion beam which comprises collimating the atoms of a material into a beam and passing the beam through a first magnetic field to separate the atoms therein into first and second groups. Atoms contained in the second group are then removed from the beam and the beam is passed through combined direct-current and radio-frequency magnetic fields. The beam is then passed through a second magnetic field to separate the atoms therein into third and fourth groups. Atoms contained in the fourth group are removed from the beam and the beam is ionized to produce a beam wherein the ions are completely polarized. (AEC)

38358 DATA SHEETS FOR DESIGNING TIME CONSTANTS FOR LOG-N PERIOD METER AND CONSIDERATIONS THEREON. Furukawa, Tomozo (Univ., Hokkaido, Japan). Nippon Genshiryoku Gakkaishi, 11: 347-52(1969). (In Japanese).

As measures to determine the performance of log N period meters, use can be made of (a) fluctuations due to statistical data from the detection process, (b) power overshoot due to scram delay, and (c) transient overshoot during a given period. While (a) is related to the time constants by a simple analytical expression, evaluation of (b) and (c) requires numerical calculation. Convenient formats for data sheets to be used in evaluating the performances (b) and (c) accompanying exponentially increasing power are presented. The parameters are chosen as follows: (a) Inverse period of exponentially increasing power normalized with reference to scram level, (b) time constant of the period meter similarly normalized, and (c) initiating time constant of log N amplifier normalized with reference to period meter time constant. The following behavior has been noted: (a) When the margin of power overshoot is the preponderant factor, evaluation of the transient initiated at a high power is enough, (b) the transient overshoot represented in terms of inverse period has a maximum at a certain period meter time constant. Using these data sheets, the constants, commonly used in reactor instrumentation in Japan have been rescrutinized, and proposals presented on the necessity and the possibility of revising them. (auth)

38359 ENHANCEMENT OF PHOTOMULTIPLIER SENSITIVITY BY AN OPTICAL METHOD. Aarons, B. D.; Manuel, J. (Univ. of New South Wales, Kensington). J. Phys., E (London), 2: 734-5(Aug. 1969).

Previous results relating to the increase of quantum efficiency in phototubes were confirmed and the effect is described and investigated further. Quantitative measurements demonstrated the existence of multiple reflections in the tube window and the relative contribution of each reflection to the sensitivity increase was measured. (auth) (UK)

38360 MEASUREMENT OF PEAK KILOVOLTAGE OF LOW ENERGY X-RAY GENERATORS. Jones, D. E. A. (Mount Vernon Hospital, Northwood, Eng.). Phys. Med. Biol., 14: 495-6(July 1969).

A method for determining peak kilovoltage in the x-ray diagnostic range devised at Mount Vernon Hospital is described. The method makes use of the K-edge absorption process. Data obtained using a Ni/Cu and a Cu/Zn filter are given. (UK)

38361 HIGH PERFORMANCE, PROGRAMMABLE 25-kV, 2-A POWER SUPPLY (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1885). 1 drawing.

A rugged, versatile, high-performance, 50-kV high voltage power supply was developed for the ion source of "Alice." The high voltage output is applied across the extraction apertures to create the high field gradient required to extract an ion beam from the source plasma discharge chamber. The output voltage is adjustable from 200 V to 25 kV. The maximum load current is 2A. Output voltage is regulated to within ±0.05% for ±5% line and ±10% load changes. Peak-to-peak output ripple and noise do not exceed 5V. An adjustable current limit feature causes the regulator system to instantaneously change from voltage regulating mode to current limiting mode at the current limit set point. The output can be modulated or programmed from a low level input signal to a peak-to-peak amplitude of 20 kV at up to 100 Hz and for linearly decreasing amplitude vs. frequency down to 100 V at 10 kHz. Regulation and control are accomplished by a single water-cooled power-electrode series pass tube in the output line. Other circuitry consists of board mounted solid-state components and discrete circuit elements. A single power transistor drives the grid of the HV regulator tube. A photon-coupled isolator is used to couple the output of the ground potential regulator amplifier to the series pass-tube control circuit which is floating at the output high voltage. (For details see TID-4100 Suppl. 54) (F.S.)

38362 FUEL DISTRIBUTION ANALYZER (FDA) (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, S. C.). (CAPE-1889). 37 drawings.

Variations in composition in individual fuel elements can cause hot spots or meltdown in a reactor operating at high power. This instrument was developed to measure the uniformity of U distribution in fuel elements by determining the attenuation of x-rays that pass through the fuel. The equipment consists of a mechanical scanner, an x-ray source, x-ray scintillation probes, amplifying circuits, and a data acquisition system. Tube fuel elements containing an alloy of enriched U and Al are rotated and translated past the detector probe in a spiral scanning action to inspect the complete tube. The detector probe is mounted on a rigid arm that is centered in a tube bore. The x-ray beam is collimated by a window in the lead shield surrounding the detector probe. The data acquisition system provides information for analysis on a central computer. Computer programs analyse data quickly providing substantial cost savings over manual analyses. (For details see TID-4100 Suppl. 54) (F.S.)

38363 EQUIVALENT CIRCUIT OF A SUPERCONDUCTING BOLOMETER. Maul, M. K.; Strandberg, M. W. P. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 40: 2822-7(June 1969).

The theory of superconducting bolometer operation is presented and a small-signal equivalent circuit developed. This circuit contains a portion that represents dynamic thermal effects and a portion resulting from superconductive phenomena. It is shown that the incremental impedance is greater than the dc resistance even for the limit of zero-frequency modulation. A peaking phenomenon is predicted in the incremental impedance versus temperature for this circuit. The characteristic parameters of a tin superconducting bolometer are presented to indicate the usefulness of incremental impedance measurements in determining these parameters. (auth)

38364 LOCATING RADIOACTIVE WASTES USING INFRARED SCANNING TECHNIQUES. Jensen, J. D. (Battelle Memorial Inst., Richland, Wash.). Nucl. Appl. Technol., 7: 55-61 (July 1969).

An infrared scanning system for producing thermal contour

maps of radioactive waste storage tanks is capable of detecting a 1-ft² area on the bottom of a 75-ft diameter tank if the temperature of the scanned area exceeds the background temperature by 3°C. Representative thermal maps of storage tank bottoms with artificially-introduced target regions are illustrated. Although the scanning system is primarily intended to measure temperature differences, it can be used to make background temperature measurements in the storage tanks by use of a calibrated target. (auth)

38365 A TIME-OF-FLIGHT MASS SPECTROMETER. Wilson, D. B. (Elliott Automation Radar Systems Ltd., Boreham Wood, Eng.). Vacuum, 19: 323-5(July 1969).

A time-of-flight mass spectrometer with a resolution of 60 (10% valley) and mass range 1 to 200 scanned in 15 μsecond was developed. Ions produced by a continuous stabilized electron beam are ejected from the ionization chamber into the accelerating region by a pulse of 6 μsec duration with a repetition rate of 10 kHz. After acceleration the ions drift down a field-free tube of length 37 cm in which mass separation takes place. An electron multiplier is used as the detector, the output being displayed on a 100 mHz bandwidth oscilloscope. The instrument has a nude ion source, an overall length of 55 cm, is constructed of stainless steel and can be baked. (auth) (UK)

38366 DEVICE FOR THE MASS ANALYSIS OF CHARGED PRODUCTS OF NUCLEAR REACTIONS. Dolinov, V. K.; Zazulin, V. S.; Niyakii, S. F. (Inst. of Nuclear Physics, Moscow). Prib. Tekh. Eksp., No. 1, 57-61(Jan.-Feb. 1969). (In Russian).

A device for the mass analysis of charged products of nuclear reactions using two detectors for a telescope is described. The multiplication of the amplitudes of the two pulses is accomplished using a logarithmic attenuator. (tr-auth)

38367 SMALL MAGNETIC MASS SPECTROMETERS AS RESIDUAL GAS ANALYSERS. McCracken, G. M. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Vacuum, 19: 311-15(July 1969).

The advantages and limitations of using small magnetic mass spectrometers as residual gas analyzers are reviewed with reference to some of the commercially available instruments. (auth) (UK)

38368 OPERATION OF THE HOT CATHODE IONIZATION GAUGE IN HYDROGEN. Werner, J. G.; Leck, J. H. (Univ. of Liverpool). Vacuum, 19: 317-18(July 1969).

A number of commercially available gauges were tested for operation in hydrogen, using a conventional dynamic flow calibration system in a manifold where the test gas pressure could be controlled over the range 10^{-9} to 10^{-6} torr. The results show that low temperature electron emitters are preferable to tungsten for the cathodes. Strong evidence is presented to show that inaccuracies associated with tungsten cathodes are due to hydrogen adsorption at the grid. It is suggested that this is due to changes in the reflection coefficient of the electrons at the helical grids. (auth) (UK)

38369 APPLICATION AND OPERATION OF QUADRUPOLE MASS SPECTROMETERS IN VACUUM TECHNOLOGY. Ball, G. W. (20th Century Electronics, Croydon, Eng.). Vacuum, 19: 331-6(July 1969).

The general application of quadrupole mass spectrometers to vacuum problems and instrumentation is discussed with special regard to operation at elevated temperatures, process control, and residual gas analysis. Some new developments in this area of mass spectrometry are reviewed, and particularly certain aspects of instrumentation and automatic control. The theory of operation of this type of mass spectrometer is not treated in detail, except where it applies to an appropriate instrumental technique. (auth) (UK)

38370 RADIATION-SENSITIVE TIME-SELECTOR SWITCH. Crowe, John W. (Hughes Aircraft Co., Culver City, Calif.). IEEE (Inst. Elec. Electron. Eng.), J. Solid State Circuits, SC-4: 83-4(Apr. 1969).

One problem in the hardening of electronic systems to the effects of radiation from nuclear weapons is protection of the integrity of information on a signal channel such as a fuse arming circuit or the input circuit in the memory of a digital computer. The memory elements themselves might be insensitive to irradiation but the information still be corrupted by radiation-induced noise in the input-output circuit. The memory can be protected from external noise by a switch triggered by a radiation detector. The ideal switch for this purpose should have 2 general features: it should open with the onset of irradiation, and be controllable in reclosure; and it should generate no noise, or pedestal, of its own. In the time-selector switch described, that is triggered by ionizing radiation, 2 transistors in a balanced bridge circuit are turned on by irradiation and shunt the signal path to ground. The circuit is arranged as a 2-diode linear gate. The 2 transistors, Q_1 and Q_1, are normally not conducting. Under irradiation, Q_1 and Q_2 are turned on and present at a balanced bridge, low impedance shunt to ground. Any radiation-induced noise at the input to the switch is not passed. The switched components, Q_1 and Q_2, are their own radiation detectors; there is no inherent delay of a signal from an external detector. (BBB)

38371 CALIBRATION OF ELECTROMAGNETIC FLOWMETERS IN THE ENRICO FERMI ATOMIC POWER PLANT. Meehli, T.; Ford, J. A. (Atomic Power Development Ass., Inc., Detroit). Nucl. Appl. Technol., 7: 76-83(July 1969).

A new calibration technique has been developed for the electromagnetic flowmeters located on the 14-in. lines of the primary sodium coolant system of the Enrico Fermi Atomic Power Plant. This new calibration technique has incorporated the experimental hydraulic characteristics of the primary sodium coolant loop, the voltage outputs of the flowmeters on the 14-in. and 6-in. lines, and the original calibration of the flowmeters on the 6-in. lines. Utilizing this new calibration technique, the system pressure drop was found to vary as the 1.9th power of the flow rate of the primary system. This relationship is in good agreement with theory. A comparison of the measured sodium flow using the new calibration with the calculated value from heat balance measurements showed good agreement, with an average deviation of 1.7%. (The as-read values from the flowmeters based on the previous calibration technique, which were developed using pump hydraulic characteristics and the pump affinity laws, were too high by an average of 10%.) This new calibration technique is now being used in the Fermi plant. (auth)

38372 APPARATUS FOR REFLECTIVITY MEASUREMENT OF REACTIVE AND RADIOACTIVE MATERIALS. Jones, J. M. (Univ. of Newcastle upon Tyne, Eng.); Murchison, D. G.; Scott, E.; Pickles, S. J. Roy. Microscop. Soc., 88: 503-12(Nov. 1968).

A method of installing a microscope in a glove box which may be used to facilitate reflectivity measurements on radioactive sinters is described. It can be used on other radioactive materials that require a high degree of protection against atmospheric attacks, or which must be effectively contained because of the biological or radioactive hazards. A Leitz Epilux microscope with inclined binocular and vertical monocular tubes was installed in the glove box. Focusing arrangements involving only the stage of the microscope are essential to the system. By breaking the microscope immediately above its limb and below the tube division, versatility of the instrument was retained without disturbing the optical path of the microscope. Reflectivities can be measured with the equipment on areas with diameters as small as 4 μm using approximately monochromatic light. Measuring procedures are similar to those employed with reflectivity systems on the open bench, but some modification of technique is required. Since the glove box must be maintained at a small positive pressure, it is important to restrict as far as possible hand movements which affect the pressure level and so cause variation in the focus of the microscope through distortion of the box. While reflectivity measurements using the box are more time-consuming and fatiguing than with more conventional systems, high accuracy and reproducibility can be maintained. (BBB)

38373 EXAMPLES FOR THE APPLICATION IN PROCESS COMPUTERS TO LABORATORIES, SCIENTIFIC INSTITUTES, TESTING STATIONS, AND SPACE TRAVEL. Strasser, Guenter; Zander, Willi (Siemens Aktiengesellschaft, Karlsruhe, Ger.). Siemens Rev., 36: 229-34(June 1969).

An increasing number of process computers of the Siemens 300 system are being used with appropriate real-time peripherals for the automation of large experimental and test installations in practically all branches of science, research, and industry. Their use is described in association with automatic testers, gas chromatographs, the mass spectrometer and the single-crystal diffractometer as well as for experiments on the sector of nuclear physics, testing the first German AZUR research satellite, and at the earth station for this satellite. (auth)

38374 A FAST ELECTRONIC ISODOSE DOSE PLOTTER INTERFACE FOR ANALOG DISPLAY. King, Robert J. (Vanderbilt Univ. Hospital, Nashville). Radiology, 92: 164(Jan. 1969).

An electronic subsystem was developed which directly plots isodose contours on an X-Y recorder. All mechanical linkages such as selsyn servos, gears, cams, and switches are eliminated. The circuit response time is better than 1 ms, and therefore plotting time is limited only by detector response and X-Y recorder slew rate. Integrated circuit and printed circuit technics have been utilized, thus allowing the system, exclusive of power supplies and meters, to be placed on four 4 × 5-inch plug-in printed circuit boards. The circuit is fundamentally an analog-to-digital con-

verter, utilizing ten window detectors to convert a normalized input detector signal to an electronic switch closure for each of 10 input signal levels. The ten dual comparators are calibrated to produce an output at each of ten 10 per cent increments and an associated window width of 0.5 per cent. The switch closure is plugged into the Z axis or pen actuator of the X-Y recorder. Potentiometers on the scanner drive the X- and Y-coordinates of the recorder. With the detector scanning the radiation distribution in a raster mode, a mark will be made by the recorder at each X-Y location where the detector signal is within a window of the dual comparators. With use of a silicon P-N junction detector and a fast pico-ammeter a 30 × 30-cm plot may be completed in approximately 10 minutes or less. A block diagram of the display interface and an example of a plot of a 10 × 10-cm x-ray field from a 6 MeV linear accelerator are included. (C.H.)

38375 ACCURACY AND CHARGING SPEED IN PULSE STRETCHERS. PART 1. Casoli, P.; Manfredi, P. F. (CESNEF, Milan). Energ. Nucl. (Milan), 16: 538-46(July 1969).

Basic design suggestions for high accuracy peak stretchers are presented and the requirements of stretchers intended for high resolution nuclear spectrometry are examined. After a careful analysis of the various blocks which constitute a peak stretcher, a classification of the different diagrams is made, according to their working modes. Linearized models are then deduced and the corresponding charging speed (which determines the stretching accuracy for short input pulses) are evaluated. The theoretical conclusion as well as the general analysis of the different sources of nonlinearity gives the base for the design of four different peak stretchers, which are believed to satisfy most of practical needs. (auth)

38376 REGENERATIVE JOSEPHSON EFFECT DETECTOR FOR FAR-INFRARED RADIATION. Richards, P. L.; Sterling, S. A. (Univ. of California, Berkeley). Appl. Phys. Lett., 14: 394-6(June 15, 1969).

Experimental evidence is presented for feedback-narrowed far-infrared response of a point contact Josephson junction which is strongly coupled to a resonant cavity. The observed response shows high sensitivity (NEP $\lesssim 10^{-14}$ W/$\sqrt{\text{Hz}}$) and frequency selectivity ($Q \gtrsim 10^3$) and so is of value as a tunable narrow-band detector of millimeter and submillimeter wave radiation. The Werthamer–Shapiro theory of the nonlinear coupling of junction current to a resonant cavity was extended to include the effect of applied radiation at the cavity resonance frequency and is shown to account for the feedback narrowing. (auth)

38377 MANUALLY OPERATED APPARATUS FOR TAKING SPECIMENS FROM SURFACES BY WIPING. Braun, Helmut Wilhelm Michael (to EURATOM). British Patent 1,160,329. Aug. 6, 1969. Priority date June 27, 1966, Germany.

A manually operated apparatus for taking specimens from test surfaces for monitoring the radioactive contamination of the surface is described. (W.H.K.)

38378 IMPROVEMENTS IN AND RELATING TO LINEAR AND LOGARITHMIC ELECTRONIC CIRCUIT ARRANGEMENTS. Weill, Jacky (to Commissariat a l'Energie Atomique). British Patent 1,160,599. Aug. 6, 1969. Priority date Nov. 7, 1966, France.

An electronic circuit arrangement is described for providing simultaneously at first and second outputs respective output voltages of which the first is linearly and the second is predeterminedly non-linearly related to an input current. It is composed of an amplifier to the input of which there is applied in addition to the input current a negative feedback voltage taken across a resistor which is connected by way of a diode having a logarithmic characteristic to the output of said amplifier. The first output voltage is taken across the resistor and the second output voltage is taken across the diode. This circuit may be used for reactor control or in radiation detection instruments. (W.H.K.)

38379 FAST DC AMPLIFIER WITH STABILIZATION OF THE REST POTENTIAL. Wille, K. (Univ., Goettingen, Ger.). Nucl. Instrum. Methods, 72: 314-16(1969). (In German).

A fast linear dc-amplifier with a gain of 27 and a rise time of about 5 ns for an input and load impedance of 50 Ω has been designed. The maximum output pulse amplitude is 5 V. A small temperature dependence of gain and output baseline is obtained by way of a stabilization circuit described. (auth)

38380 USE OF A SMALL DIGITAL COMPUTER AS A 150 000 CHANNEL, TWO PARAMETER, ANALYZER. Kellie, J. D.; Crawford, G. I. (Glasgow Univ.). Nucl. Instrum. Methods, 72: 329-32(1969).

By the use of magnetic tape units as the main store, it is possible to operate a PDP 7 computer as a 150,000 channel analyzer. Various live displays are possible, so that the experimenter always has access to all of the ordered data, even during the collection period. The system can analyze up to 40 events per second with negligible losses. (auth)

38381 MINIATURE SHEATHED THERMOCOUPLES IN REACTOR ENGINEERING. Hesse, L. (Philips Industrie Elektronik, Hamburg). Kerntechnik, 11: 281-5(May 1969). (In German and English).

The range of application of miniature sheathed thermocouples in reactor engineering and in other fields is constantly increasing. The design of these thermocouples, their particular features and properties, and their behavior under irradiation are described. A few typical examples of use illustrate the wide range of possible applications. (auth)

38382 IMPROVEMENT ON TUNNEL DIODE-TRANSISTOR RING COUNTER. Tan, Z. C. (Univ. of Auckland, New Zealand). Nucl. Instrum. Methods, 72: 357-8(1969).

It is suggested that the ring counter proposed independently by Vescovi and by Baldinger and Simmen can be modified to operate without any trigger pulse width, rise-time or fall-time restrictions. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 38381 and 39540.

38383 (N-69-12257) THEORETICAL AND EXPERIMENTAL STUDIES OF RADIATION INDUCED DAMAGE TO SEMICONDUCTOR SURFACES AND THE EFFECTS OF THIS DAMAGE ON SEMICONDUCTOR DEVICE PERFORMANCE. Final Report, March 1, 1964–August 31, 1968. Lade, R. W.; Hauser, J. R. (North Carolina State Univ., Raleigh. Semiconductor Device Lab.). Sept. 1, 1968. 61p. (NASA-CR-66724; SDL-10-588). CFSTI.

A new technique employing an MOS field-effect solar cell is described for simultaneously determining both surface potential and surface recombination velocity. Gamma irradiation was found to change the surface recombination through changes in both surface potential and in the density of recombination centers. The properties and irradiation effects of semiconductors with silicon dioxide and silicon nitride insulating layers on the semiconductor were studied mainly by means of C–V measurements on metal-insulator-silicon devices. On SiO_2, the insulator charge changes and surface state density were studied for gamma irradiation. Silicon nitride insulator layers were found to be unstable because of an electronic injection from the semiconductor into the silicon nitride films. This effect was studied in detail and a model developed for this electronic type of instability. (auth) (USGRDR)

38384 (SC-RR-68-225) RADIATION EVALUATION OF THE EBERS-MOLL AND CHARGE CONTROL MODEL PARAMETERS OF SEVEN TRANSISTOR CODES. Sullivan, W. H.; Phillips, A. R.; Horning, L. K. (Sandia Labs., Albuquerque, N. Mex.). June 1968. 152p. Dep. CFSTI.

This report describes the neutron-induced changes in the large-signal model parameters for seven transistor codes. In this investigation, relatively small samples of the G657046, G657071, G657133, G657137, G657155, G657318, and G657322 device codes were evaluated. Data are presented which define each large-signal model parameter prior to irradiation at fluence levels of 1.9×10^{13} and 1.0×10^{14} NVT, E > 0.01 MeV. Also, formulas for converting the measured parameters to the Ebers-Moll model parameters and to the charge control parameters (as used in the CIRCUS circuit analysis computer program) are presented. (auth)

38385 PULSED-RADIATION-INDUCED CURRENT IN CRYSTALLINE AND FUSED QUARTZ. Okabe, S.; Tsumori, K.; Tabata, T. (Radiation Center of Osaka Prefecture). J. Appl. Phys., 40: 2894-8(June 1969).

Pulsed-radiation-induced current in crystalline and fused quartz was studied by using 5-μsec pulses of electrons with an energy of 13 MeV and a current density of about 100 mA/cm^2 peak and a few μA/cm^2 average. The pulse shape of the induced current varied remarkably with time within a few minutes of irradiation and also with the temperature of the sample. The variation in shape showed a dependence on crystal orientation of the sample. The effect of the field of the internal space charge was found to be negligible in the observed phenomena. A qualitative explanation is applied to part of the results in terms of an interaction between excited carriers and traps. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer to abstracts 38205 and 38257.

Basic Processes

Refer also to abstracts 37923, 38278, 38421, 38665, 38666, 38689, and 38725.

38386 A RADIOACTIVE TRACER TECHNIQUE FOR THE DIRECT MEASUREMENT OF THE DIFFUSION RESISTANCE OF STOMATA. Moreshet, S. (Volcani Inst. of Agricultural Research, Rehovot, Israel); Stanhill, G.; Koller, D. J. Exp. Bot., 19: 460-7 (Aug. 1968).

A new method using ^{41}Ar is described for measuring the stomatal resistance to diffusion in leaves. It consists of measuring the radioactivity of air samples that have diffused through a leaf from a porometer container enriched with ^{41}Ar. Argon-41 was selected as the diffusant because it is physiologically, as well as chemically, inert, its physical properties are similar to those of the normal atmospheric constituents, nonradioactive ^{40}Ar occurs in the atmosphere in relatively high and constant concentrations, and its molecular weight is close to that of the air as a whole. Its γ radiation is of sufficient energy (1.3 MeV) for easy measurement with existing counting systems. Its half-life is 109 min so that, when produced at relatively high activity, it can be used efficiently for at least four half-lives, i.e. over an 8 hr period. Details of the calibration are given together with the methods adopted to determine the accuracy of measurement and the optimum time of sampling. Results suggest that in the material investigated the measurements obtained are essentially those of stomatal resistance. (BBB)

38387 THYROID CONTROL AND IODINE KINETICS STUDIED WITH A WHOLE-BODY COUNTER. Myhill, J. (Royal North Shore Hospital, St. Leonards, Australia). Australas. Bull. Med. Phys. Biophys., No. 39, 7-16 (Mar. 1969).

Using a whole-body counting technique and an injection of radiothyroxine, measurements were made in euthyroid volunteers of fractional thyroxine degradation rate, total whole-body thyroxine turnover, thyroidal secretion of thyroxine, and the thyroidal uptake of ^{127}I. The measurements were made in 18 subjects during the administration of 0, 100, and 200 microgrammes of thyroxine per day in successive seven-week periods, and in 10 subjects during the administration of 0, 252, and 1009 microgrammes of iodide daily in successive thirteen-week periods. The fall in thyroidal secretion rate was found to be quantitatively identical to the fall in radioiodine clearance rate which occurs when thyroxine is administered. On the administration of iodide the thyroidal radioiodine clearance fell, the thyroidal up-take of ^{127}I rose, and the total-body turnover of thyroxine remained constant. Serum thyroxine iodide was negatively correlated with fractional thyroxine degradation rate. It was concluded that the thyroid-pituitary regulation operates to ensure a constant total-body turnover of thyroxine. (Australia)

38388 QUANTITATIVE STUDIES ON ENZYMES IN STRUCTURES IN STRIATED MUSCLES BY LABELED INHIBITOR METHODS. II. CONFIRMATION OF RADIOAUTOGRAPHIC MEASUREMENT BY LIQUID-SCINTILLATION COUNTING. Rogers, A. W.; Barnard, E. A. (State Univ. of New York, Buffalo). J. Cell Biol., 41: 686-95 (June 1969).

Fragments of mouse diaphragm and sternomastoid muscles were incubated in diisopropylfluorophosphate (DFP)-^{3}H in conditions known to saturate all the available DFP-sensitive reaction sites. After being extensively washed, the enzyme acetylcholinesterase (AChase) was specifically reactivated by treatment with pyridine-2-aldoxime methiodide (2-PAM). The radioactive DP-groups released into solution by 2-PAM were measured by liquid scintillation counting, and related to the known number of motor endplates present. Considerable difficulty was encountered in reducing the excess, adsorbed radioactivity to acceptable levels: long washing routines, extraction with organic solvents, and removing excess muscle fiber by microdissection were necessary. Six experiments gave a mean value of 2.4×10^{7} molecules AChase per sternomastoid endplate, in reasonable agreement with the previously reported measurements by autoradiography. (auth)

38389 DYNAMIC STATE OF THE SPLEEN CELLS OF MICE AFTER ADMINISTRATION OF THE ENDOTOXIN OF PROTEUS VULGARIS. 1. CELLULAR PROLIFERATION AFTER ADMINISTRATION OF THE ENDOTOXIN. Takano, Tatsuya; Mizuno, Denichi (Tokyo Univ.). Jap. J. Exp. Med., 38: 171-83 (June 1968).

Phosphorus-32 was injected into mice intraperitoneally, and the fate of ^{32}P incorporated into RNA and DNA was investigated. Disappearance of ^{32}P and its rapid incorporation into DNA were observed in the spleen. This was not due to turn-over of DNA at a molecular level in the cells, but to proliferation of cells. The behavior of these cells was analyzed biochemically by estimation of the contents of DNA and RNA and the rate of formation of ^{32}P-RNA and -DNA. Splenomegaly took place from 5 to 8 days after administration of endotoxin of Proteus vulgaris. At this time, endotoxin stimulated cellular proliferation, whereas no change was observed in the apparent generation time of 0.85 days. On the other hand, the half life of RNA at this stage was shortened from 2.1 days to 1.1 by endotoxin treatment. This discrepancy was discussed and it was concluded that cells with rapid mitosis and low RNA metabolism differentiate into mature cells with slow mitosis. (NSA of Japan)

38390 ANTIVASOPRESSIN ANTIBODY. CHARACTERIZATION OF HIGH-AFFINITY RABBIT ANTIBODY WITH LIMITED ASSOCIATION CONSTANT HETEROGENEITY. Wu, Wen-hsien; Rockey, John H. (Univ. of Pennsylvania, Philadelphia). Biochemistry, 8: 2719-28 (July 1969).

High-affinity antivasopressin antibody with limited association constant heterogeneity was induced in rabbits by immunization with vasopressin coupled by carbodiimide-initiated amide linkage to equine γGab-globulins, and also by immunization with unmodified vasopressin. The antivasopressin antibodies of hyperimmune antisera were shown to be 7S γG-globulins by radioimmunoelectrophoresis and sucrose density gradient ultracentrifugation. Radioimmunoprecipitation vasopressin binding curves were constructed with ^{131}I vasopressin, employing sheep antirabbit γG-globulin serum to precipitate the complexes of rabbit antivasopressin antibody and radioiodinated vasopressin. The ability of analogs of vasopressin and chemically modified vasopressin to displace radioiodinated vasopressin from antivasopressin antibody was evaluated by constructing radioimmunoassay inhibition curves. (auth)

38391 RADIOISOTOPES IN THE MEASUREMENT OF ABSORPTION OF WASHOUT FLUID DURING TRANSURETHRAL PROSTATE RESECTION. Madsen, P. O.; Oester, Arne (Veterans Administration Hospital, Madison, Wis.). Urologe, 7: 110-11 (Mar.-Apr. 1968). (In German).

A double radioisotope method for evaluation of the fraction of washout fluid absorbed directly intravenously, and what fractions are absorbed retroperitoneally or perivesically during transurethral prostate resection, is described. The method uses ^{131}I-labeled serum albumin and ^{125}I-labeled iodothalamate added to the washout fluid. The ^{131}I activity in the blood indicates the amount of fluid absorbed intravenously, and the 24 hr excretion of ^{125}I following surgery indicates the total amount absorbed. In 20 cases the fluid absorption was from 12 to 4502 ml. Up to 90% of the absorbed fluid was absorbed directly intravenously, with an average of 21%. (BBB)

38392 PANETH AND GOBLET CELL RENEWAL IN MOUSE DUODENAL CRYPTS. Troughton, W. David; Trier, Jerry S. (Univ. of New Mexico, Albuquerque). J. Cell Biol., 41: 251-68 (Apr. 1969).

Proliferation of Paneth and goblet cells of mouse duodenal crypts was studied by high resolution light microscope radioautography. In one group of mice, blood levels of thymidine-^{3}H were sustained for up to 12 hr by repeated injections of isotope to facilitate identification of proliferating cells. In these animals, many goblet cell nuclei incorporated thymidine-^{3}H whereas only one of 6261 tabulated Paneth cells was labeled. Cells intermediate in structure between undifferentiated and goblet cells and between undifferentiated and Paneth cells were identified and their light and electron microscopic features are described. A significant number of these intermediate cells incorporated thymidine-^{3}H into their nuclei. Another group of mice received a single injection of thymidine-^{3}H. These animals were killed 4 hr to 29 days after isotope administration. Goblet cells and intermediate cells with labeled nuclei were identified 4 hr after thymidine-^{3}H but could not be seen after 15 days. In contrast,

Paneth cells with labeled nuclei were not observed until 24 hr after thymidine-^{3}H but were still present at 29 days, long after labeled undifferentiated, goblet, and intermediate cells had disappeared. We conclude that differentiated Paneth cells in mouse duodenum do not normally proliferate, but, instead, arise by differentiation from undifferentiated crypt cells or from intermediate cells. Moreover, once formed, Paneth cells persist in crypts for a prolonged period. In contrast, intermediate cells and crypt goblet cells proliferate actively and are less stable cell populations than differentiated Paneth cells. The precise function of the intermediate cells is not known, but they may represent transition forms between undifferentiated cells and the more mature secretory cells. Damage of crypt epithelial cells, thought to be caused by radiation effects, was evident in both groups of mice. (auth)

38393 RESOLUTION AND EFFICIENCY IN ELECTRON-MICROSCOPIC AUTORADIOGRAPHY USING RADIOACTIVE CALCIUM. Huxham, G. J.; Lipton, A.; Howard, Barbara, M. (Queensland Univ., Brisbane). Aust. J. Exp. Biol. Med. Sci., 47: 299-304(June 1969).

Autoradiographs of small deposits of (^{45}Ca)F_2 have been examined in the electron microscope to measure resolution and efficiency of the $^{45}Ca^{2+}$ emission. Resolution was found to be 3050 Å ± 500 Å and efficiency (grains from 100 disintegrations) was 3.0. A formula is proposed for estimating the radiographic procedures. This is used to predict the uptake required to produce satisfactory autoradiographs with $^{45}Ca^{2+}$ in mammalian smooth muscle. It is suggested that insoluble deposits of other isotopes may be used for estimation of resolution and efficiency in autoradiography. (Australia)

38394 IMMUNOGLOBULIN AND SPECIFIC ANTIBODY SYNTHESIS IN A CHRONIC INFLAMMATORY FOCUS: ANTIGEN-INDUCED SYNOVITIS. Jasin, Hugo E.; Ziff, Morris (Univ. of Texas, Dallas. Veterans Administration Hospital, Dallas). J. Immunol., 102: 355-69(Feb. 1969).

Incorporation of ^{14}C-amino acids into immunoglobulin and specific antibody (anti-bovine serum albumin (BSA)) was measured simultaneously in synovial membrane, buffy coat cells, and spleen cells of rabbits, utilizing a coprecipitation technique. When immunoglobulin synthesis was measured in the synovial membranes of normal rabbits, small but significant amounts of newly-synthesized immunoglobulin were detected. In one of these animals undergoing a secondary response to BSA, 39.3% of the radioactive γ globulin synthesized by the synovium was accounted for as anti-BSA. At the same time, 28.4% and 67.2% of the immunoglobulin synthesized by the buffy coat and spleen cells was also anti-BSA. It was concluded that antibody-forming cells of the recirculating lymphocyte pool enter normal tissue. A synovial inflammatory reaction (chronic arthritis) was produced by three intra-articular injections of BSA. This was dependent on the appearance of systemic immunity to BSA since no synovitis developed in immunologically tolerant animals. Observations indicated that immunoglobulin and specific antibody-synthesizing cells accumulate in chronic inflammatory foci produced by local injection of antigen or nonspecific inflammatory agents and that the specificity of such antibody-producing cells reflects the overall immune status of the host. (C.H.)

38395 CHARACTERISTICS OF ANTIBODY TO A LIMITED ANTIGENIC STIMULUS. Haber, Edgar; Stone, Marcia (Massachusetts General Hospital, Boston. Harvard Medical School, Boston). Israel J. Med. Sci., 5: 332-7(May-June 1969).

Three of 15 rabbits immunized with a branched-chain polymer of angiotensin II and succinylated poly-L-lysine produced hapten specific antibody. Antibody titers were uniformly low. The electrophoretic mobility of the antibodies was restricted so that it occupied a limited portion of the γG-globulin arc on immunoelectrophoresis. Each of the responders produced an antibody with a unique binding constant that did not change over a period of 120 days. These findings suggest that a relatively simple and poorly immunogenic antigen may stimulate a single clone of cells. (auth)

38396 A RADIO-LIGAND BINDING ASSAY SYSTEM FOR ESTRADIOL MEASUREMENT IN HUMAN PLASMA. Korenman, Stanley G.; Perrin, Laurence E.; McCallum, Theresa P. (Harbor General Hospital, Torrance, Calif. Univ. of California, Los Angeles). J. Clin. Endocrinol. Metab., 29: 879-83(July 1969).

A new, convenient, specific, sensitive, reproducible radio-ligand binding assay system for measurement of estradiol in human plasma was developed. The procedure compares the ability of standards and unknowns to compete for binding sites on the specific estrogen binding protein of rabbit uterine cytosol. Blank values approached 0. The mean estradiol concentration was 15 pg/ml in post-menopausal women, 24.0 pg/ml in adult men, 65.6 pg/ml during days 1 to 10 of the menstrual cycle, 124.5 during days 11 to 20, and 137.2 during days 21 to 31. (auth)

38397 IMMUNOCHEMICAL ANALYSIS OF MYCOPLASMA PNEUMONIAE. 3. SEPARATION AND CHEMICAL IDENTIFICATION OF SEROLOGICALLY ACTIVE LIPIDS. Plackett, P. (Commonwealth Scientific and Industrial Research Organization, Melbourne); Marmion, B. P.; Shaw, Elizabeth J.; Lemcke, Ruth M. Aust. J. Exp. Biol. Med. Sci., 47: 171-95(Apr. 1969).

Lipids of Mycoplasma pneumoniae were fractionated by chromatography on columns of diethylaminoethylcellulose and silicic acid, and on thin layers of silica gel G. Hapten activity, measured in complement-fixation tests with rabbit and with human antisera to M. pneumoniae, was found to be associated with four or more neutral glycolipids. These comprised digalactosyl- and trigalactosyldiglycerides, a second dihexosyldiglyceride containing both glucose and galactose, and a trihexosyldiglyceride fraction containing both hexoses, which was probably a mixture of two or more substances. These glycolipids were labelled when the organisms were grown in the presence of radioactive glucose, glycerol or palmitate, but not when they were grown with labeled galactose. The label from glucose appeared in both the glucose and moieties of these glycolipids. A fraction, consisting mainly of alkali-stable glycolipids, into which there was little or no incorporation of isotope during growth with labeled precursors, was also found to have hapten activity. Rabbit antisera to M. pneumoniae were found to cross-react with glycolipids from other sources, including the ceramide lactoside of mammalian tissues (cytolipin H). Chloroform-methanol extracts of M. pneumoniae contained large amounts of lecithin, which was not labeled during growth with the isotopic precursors used. The major phosphatide synthesized by the organisms was phosphatidylglycerol. This was accompanied by smaller amounts of another phosphatide, tentatively identified as a phosphatidyl monoglyceride, which fixed complement with Wassermann-positive human sera. These two acidic phosphatides were found to be radioactive after the cells had been grown with labeled glycerol or palmitate. (Australia)

38398 CONSIDERATIONS ON THE CALCULATION OF THE MEAN LIFE SPAN OF RED CELLS LABELED WITH RADIOACTIVE BLOOD PROPOSAL OF A NEW METHOD. Barbina, V.; Di Chiara, F.; Zecchin, R.; Englaro, G. C. (Ospedale Civile, Udine, Italy). Radiol. Med., 54: 1191-1201(Nov. 1968). (In Italian).

The value of the method for the calculation of the life span of red cells using ^{51}Cr-labeled sodium chromate as the tracer is discussed. The slope of the curves during the first days is analyzed in relation to two general cases: a chronic hemolytic intrinsic condition and an iperhemolytic extrinsic indiscriminate action. On the basis of the correlation observed between the initial slope of the curve and the values of the mean cellular life span, a new simplified method for the calculation of the mean life of red cells is suggested. (auth)

38399 SOME CRITICAL FACTORS IN DOUBLE ANTIBODY RADIOIMMUNOASSAY SYSTEMS UTILIZING SHEEP ANTI-RABBIT PRECIPITATING SERA FOR MEASUREMENT OF HUMAN SERUM LH, FSH, AND HGH. Burr, I. M.; Grant, D. B.; Sizonenko, P. C.; Kaplan, S. L.; Grumbach, M. M. (Univ. of California, San Francisco). J. Clin Endocrinol. Metab., 29: 948-56 (July 1969).

The dynamics of the precipitation of labeled tracer hormones (human growth hormone, luteinizing hormone, and follicle-stimulating hormone)-antibody complexes were investigated utilizing a rabbit antisera directed against the hormone and sheep anti-rabbit gamma globulin precipitating sera. Studies were performed in buffer alone and in the presence or absence of EDTA, varying quantities of normal human serum, heated human serum, a human euglobulin fraction and the serum supernatant remaining after precipitation, normal rabbit serum, and rabbit serum that was frozen and thawed repeatedly. Both EDTA and normal human serum enhanced precipitation when added separately. The enhancement when both were present was greater than that due to either alone and was proportional to the amount of human serum added. The effect of human serum was reproduced by the euglobulin fraction; the serum supernatant had no effect. Heating the human serum inhibited this enhancement. Repeated freezing and thawing of the normal rabbit serum abolished the enhancement of precipitation due to normal rabbit serum. Addition of human serum with the precipitating antibody to standards reproduced the conditions found in samples. Unlabeled hormone added with the precipitating antisera had no effect. These results indicate that human serum accelerated the precipitation reaction and that this effect was enhanced in the presence of EDTA. It is suggested that the effect of human serum may be due to C'1q of complement, found in the euglobulin fraction. These findings may explain some

of the discrepancies obtained when serum luteinizing hormone and follicle-stimulating hormone are assayed utilizing double antibody radioimmunoassay methods with a sheep anti-rabbit gamma globulin precipitating system. Equalization of the human serum content of all samples and of the standards at the time of the precipitation reaction may minimize these discrepancies. (auth)

38400 MEDICAL PREPARATIONS LABELLED WITH RADIOACTIVE ISOTOPES. Herzmann, H. (Institut fuer Angewandte Isotopenforschung, Berlin). Isotopenpraxis, 5: 125-8(Apr. 1969). (In German).

After giving a historic survey of the evolution of manufacturing medical preparations labeled with radioisotopes in Germany, some nuclear pharmaceuticals are described in detail showing, in addition to the principles of synthesis and analysis, the most important fields of their application. The main directions of developing new preparations are pointed out in the light of some fields of research. (auth)

38401 METABOLISM AND TOXICITY OF THERAPEUTIC CHELATING AGENTS. PART 6. HISTOAUTORADIOGRAPHIC LOCALIZATION OF EDTA IN ORGANS OF THE RAT. Weber, Klaus M. (Kernforschungszentrum, Karlsruhe, Ger.). Strahlentherapie, 137: 708-11(June 1969). (In German).

In a rat injected with ^{14}C-labeled EDTA ^{14}C-activity could be demonstrated by histoautoradiography in the straight portions of the proximal tubules of the kidney, in the mucosa and the cryptes of the duodenum. Less ^{14}C-activity was associated with liver parenchyme while no activity could be found in pancreas or adrenals. An intracellular permeation of EDTA and/or its metabolites appears to be likely. The significance of the findings for the histopathological effects of EDTA is discussed. (auth)

38402 STUDIES ON OVULATION BY RADIOIMMUNOLOGIC DOSE OF PLASMA LH IN NORMAL AND PROGESTIN-TREATED SHEEP. Pelletier, Jean; Thimonier, Jacques Compt. Rend., Ser. D, 268: 573-6(Jan. 20, 1969). (In French).

During ovulation the content of LH in the plasma increased approximately 50 times in comparison with the level of the mean base (2 ng/ml). The maxima detected were significantly higher in the untreated ewes (137 ng/ml) than in those receiving progesterone (78 ng/ml). The increase of LH in the blood was observed for a duration of 12 hrs. (tr-auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 38520, 38521, 38554, 38566, 38654, 38677, 38794–38797, and 38800.

38403 INFLUENCE OF SOME CHELATING AGENTS ON RADIOSTRONTIUM METABOLISM. Kostial, K.; Vojvodic, S.; Maljkovic, T. (Institut za Medicinska Istrazivanja i Medicinu Rada, Zagreb). Arh. Hig. Rada Toksikol., 18: 111-23(1967). (In Slovak).

The efficiency of several chelating agents CPDTA (cyclopentanediamine tetraacetic acid), DIMEDTA (dimethylethylenediamine tetraacetic acid), and PDTA (propylenediamine tetraacetic acid) in influencing the skeletal retention of ^{85}Sr was tested on rats. Intraperitoneal injection of ^{85}Sr was immediately followed by intraperitoneal injection of chelating agents applied as disodium salts of strontium chelates in a dose of 0.8 μ mole/kg. The retention of ^{85}Sr in the skeleton was measured 72 hr after injection. It was found that only CPDTA with the highest stability constants for calcium and strontium and lowest ratio of constants caused a 20% reduction of ^{85}Sr retention. The effect was independent of the age and sex of the animals and the way of parenteral application of ^{85}Sr (subcutaneous or intraperitoneal injection). Rats treated with strontium chelates of CPDTA, EDTA (ethylenedamine tetraacetic acid), and BADE (2:2 bis/di/carboxymethyl/aminodiethylether) immediately after oral application of ^{85}Sr by stomach tube showed increased skeletal ^{85}Sr retention of 25 to 50%. It was concluded that this presents additional difficulty in applying therapy with chelating agents in the case of radioactive strontium contamination. (Bull. Sci.) (TSS)

38404 CLINICAL AND EXPERIMENTAL STUDIES OF THE UPTAKE OF RADIOACTIVE COPPER THROUGH THE PLACENTAL MEMBRANE IN PREGNANT WOMEN. Nikolov, N.; Bozhkov, B.; Gunev, V. Akush. Ginekol., 6: 475-9(1967). (In Russian).

The passage of radioactive copper through the placenta was measured in 10 women admitted to the clinic for interruption of pregnancy. Five of them were in the first three months and 5 in the second three months of pregnancy. Prior to the interruption, the women were given orally a solution of copper sulfate containing ^{64}Cu. With the first group the interruption was performed 90 to 135 minutes after taking the radioactive copper. Four women of the second group aborted 10 to 15 hours after having taken the isotope. In the first group of patients the whole fetus and in the second group the liver only was examined for ^{64}Cu uptake. The investigation showed that soon after administration the radioactive copper passed through the placenta and was found in high concentration in the fetal tissue. In the second group, the concentration of radioactive copper was two to three times higher in the fetal tissue than in the mother's serum. (auth)

38405 METAL METABOLISM IN NEUROLOGICAL DISEASE. CONCERNING THE RELATIONSHIP BETWEEN AMYOTROPHIC LATERAL SCLEROSES AND THE METABOLISM OF MANGANESE. Yoshimasu, Fumio (Wakayama Medical Coll., Japan). Wakayama Igaku, 20: No. 1, 31-50(Feb. 1969). (In Japanese).

For the purpose of pursuing the relationship between the occurrence of amyotrophic lateral sclerosis (ALS) and the metabolism of manganese in man, neutron activation analysis was carried out on the following materials: Central nervous system tissue from three autopsied cases of ALS and their respective controls (acute death). Environmental factors such as hair of cattle, soil, water, etc., from areas of high incidence of ALS (Kozagawa Area, Japan and Guam) and their respective controls. The methodology in neutron activation analysis using biological samples was carried out with difficulty. A significant difference in pattern of distribution of manganese in CNS tissue appeared between the ALS cases and the control cases: Distribution of manganese in the brain of the ALS cases was relatively uniform as compared with that of the control cases. Content of manganese was higher in the spinal cord than in the whole brain in the ALS cases, while in the control cases the relationship was opposite. A significant seasonal variation in manganese content found in hair of cattle appeared between the area of high incidence (Kozagawa Area) and the control area. In general, content of manganese in soil, river and drinking water was greater in areas of high incidence of ALS (Kozagawa and Guam) than in the control area. Consideration of the possible relationship of manganese metabolism in CNS tissue and certain neurological diseases is discussed. (NSA of Japan)

38406 METABOLISM OF PLUTONIUM IN ADULT RABBITS. Taylor, D. M. (Royal Cancer Hospital, Sutton, Eng.). Brit. J. Radiol., 42: 44-50(Jan. 1969).

The distribution and retention of ^{239}Pu was studied in adult rabbits after intravenous or intramuscular injection of plutonium nitrate. After both intravenous and intramuscular injections the patterns of distribution and retention in the tissues are broadly similar to those found in other animal species. After intramuscular injection the bulk of the plutonium remains at the site of injection for at least one year. Translocation of plutonium from the intramuscular injection site is initially slow, and the major sites of deposition are the liver and skeleton, but after about seven weeks a marked increase was observed in the proportion of the translocated material deposited in the liver. It is suggested that more than one mechanism may be involved in the transport of plutonium from a deposit in muscle. The intracellular distribution of plutonium was studied in liver, at various times after intravenous injection, by sucrose density gradient centrifugation. Initially the plutonium in the liver was found to sediment with the microsomes and light cell components, but by 16 weeks the majority of the plutonium was found to sediment with the mitochondrial fraction. (auth)

38407 INFLUENCE OF LACTATION ON RETENTION OF RADIOSTRONTIUM IN MICE. Roennbaeck, C.; Nelson, A.; Nilsson, A. (Research Inst. of National Defence, Sundbyberg, Sweden). Acta Radiol., Ther., Phys., Biol., 7: 330-6(Oct. 1968).

The radionuclide ^{85}Sr was administered to female mice 41, 23, and 1 day, respectively, before start of lactation, and the retention was studied during the following 3 months. The excretion rate decreased with increasing interval between administration and lactation. Even the group receiving ^{85}Sr 41 days prior to lactation displayed enhancement of the excretion rate during lactation. (C.H.)

38408 INVESTIGATION INTO A MODIFICATION OF THE BIPHASIC ^{131}I TEST. Emrich, D.; Sommer, J. (Univ., Goettingen, Ger.). Ger. Med. Mon., 14: 109-14(Mar. 1969).

An improved, shortened version of the 2-phase ^{131}I test was developed. The biphasic ^{131}I test (determination of ^{131}I uptake by the thyroid after 2, 24, and 48 hr and plasma ^{131}I or PB^{131}I activity after 48 hr) gives an indication of the iodine and hormonal phases of radioiodine utilization by the thyroid. Plasma conversion rate was measured 2 to 6 hr after oral administration of ^{131}I in 699 patients with normal or abnormal thyroid function. In the early phase of euthyroidism and in decompensated hyper-

thyroidism (both in persons from endemic goiter areas and those from areas without endemic goiter) measurement of the ^{131}I conversion rate in the described manner provided a satisfactory differentiation in 90% of cases. In euthyroid cases it was influenced less by changes in sp act. than the total act. of ^{131}I in plasma or $PB^{131}I$ after 48 hr. In addition, the conversion rate after 2 and 4 hr allowed the differentiation from decompensated hyperthyroidism in 80 to 90% of cases, which is not possible with the conventional 2-phase test. The results were confirmed by simultaneous measurement of PBI in a number of cases. The conversion rate in the early phase of hypothyroidism is of little help. In such cases measurement after 24 hr is necessary. The following modified shortening of the 2-phase test is suggested: in euthyroidism and hyperthyroidism, ^{131}I uptake by the thyroid gland is measured after 4 and 24 hr and the conversion rate after 4 hr in hypothyroid cases after 24 hr. The 2-phase test may be completed within 4 hr without significantly decreasing its diagnostic value. (BBB)

38409 THYROIDAL RADIOIODINE UPTAKE VALUES IN EUTHYROID SUBJECTS IN BIRMINGHAM, ALABAMA. Pittman, J. A. Jr.; Thomas, J. L.; Dale, R. C.; Dailey, G.; Beschi, R. J.; Kontzen, F. N. (Veterans Administration Hospital, Birmingham, Ala.). Ala. J. Med. Sci., 6: 46-52(Jan. 1969).

The normal value of ^{131}I uptake by the thyroid was studied in a population with abundant dietary iodine intake. Use of several phantoms to calibrate instruments to measure ^{131}I metabolism is described. The thyroidal ^{131}I uptake was determined in 53 subjects during the summers of 1967 and 1968. The ^{131}I (1 to 4 μCi) was administered orally, this route having been shown to cause only minimal alterations of thyroidal radioiodine clearance measured at 4 hr or later, as compared with the intravenous route. The counting procedure consisted in use of the thigh background to correct for nonthyroidal neck activity. The mean value for the 24-hr thyroidal ^{131}I uptake using a wooden phantom was 15.4%. Including 2 standard deviations, the normal range was 2 to 29%. Using a Lucite phantom the 24-hr mean value was 12.7%. The uptake values for 4, 6, and 24 hr and the serum PBI concentrations for the individual subjects are also given. The present results demonstrate that each radioisotope lab should continually not only calibrate its instruments but also re-evaluate the "normal values" for its own population. (BBB)

38410 INFLUENCE OF RADIOACTIVITY OF THE ENVIRONMENT IN THE STUDY OF CELLULAR GROWTH. Planel, H.; Soleilhavoup, J. P.; Caratero, C.; Tixador, R.; Caratero, A. (Faculte de Medecine, Toulouse). Compt. Rend. Soc. Biol., 162: 1215-19(1968). (In French).

Cultures of Paramecium caudatum were placed in a water bath filled with ordinary water, in a water bath filled with distilled water, in a water bath filled with distilled water containing 2 mg of thorium nitrate per liter, and in contact with air in a thermostatic heating chamber. The growth rates in the various environments were studied. The populations in the water bath of ordinary water increased progressively until the eighth day and then entered a regressive phase. The cultures in contact with the air had a comparable evolution, but the populations were numerically inferior. The populations of cultures in ordinary water were higher than that of cultures in distilled water. The addition of thorium nitrate to distilled water causes a slight acceleration of growth with respect to ordinary water. (J.S.R.)

38411 MOVEMENT OF FOLIAR-APPLIED ^{45}Ca IN BRUSSELS SPROUTS. Millikan, C. R.; Hanger, B. C. (Victorian Plant Research Inst., Burnley, Australia). Aust. J. Biol. Sci., 22: 545-58(June 1969).

Calcium-45 remained virtually immobile when applied to the surface of the middle leaves of Brussels sprouts in doses containing extra non-radioactive calcium plus either water, citric acid, malic acid, diphenylamine, dimethylsulphoxide, or oxalic acid. By contrast, the mobility of ^{45}Ca injected in the midrib of corresponding leaves was markedly influenced by the nature of the additive. Water, diphenylamine, dimethylsulphoxide, or oxalic acid had little effect, while citric acid and malic acid resulted in acropetal and basipetal movement. Even after 7 days, the movement was largely restricted to the side of the plant with the treated leaf in the middle. The movement of methylene blue added as a marker to the injected ^{45}Ca dose containing extra non-radioactive calcium plus malic acid remained largely confined to the xylem of the petiole and later up and down in the xylem of the stem. ^{45}Ca had moved ahead of the marker after 10 min and occurred in all vascular tissues and surrounding parenchyma of the petiole. Movement of ^{45}Ca away from the xylem was first apparent 20 min after injection. At 60 min ^{45}Ca occurred in fascicular parenchyma, phloem, and phloem parenchyma, but not in the xylem. Movement of ^{45}Ca in the stem occurred in phloem as well as in xylem. These differences in the movement of marker and ^{45}Ca were recorded for dry, moist, and saturated plants. (Australia)

38412 INTERACTION BETWEEN CALCIUM LEVEL AND NITROGEN SOURCE ON GROWTH AND ^{45}Ca DISTRIBUTION IN SUBTERRANEAN CLOVER. Millikan, C. R.; Hanger, B. C.; Bjarnason, E. N. (Victorian Plant Research Inst., Burnley, Australia). Aust. J. Biol. Sci., 22: 535-44(June 1969).

Using either ammonium or nitrate as the nitrogen sources, dry matter yields were highest from plants grown on a normal calcium nutrition, whereas plants supplied with urea grew best at low calcium level. When ammonium and nitrate were added together, yields were independent of the calcium concentration in the substrate. Plants fed solely ammonium nitrogen made extremely poor growth. The main factor affecting ^{45}Ca distribution within subterranean clover was the calcium concentration in the substrate. The percentage of ^{45}Ca retained in the roots was greatest at the low calcium level. At this level it was also greatest in the plants fed ammonium and least in those fed ammonium plus nitrate. The concentration of ^{45}Ca in plant tops was equal in the presence of ammonium plus nitrate or urea, and higher than with nitrate or ammonium. Between nitrogen sources the lamina : petiole, leaf edge : leaf center, and petiole distal : petiole proximal ratios of ^{45}Ca concentrations were different at the low, but not at the normal, calcium level. (Australia)

38413 COBALT DISTRIBUTION IN SEVERAL PASTURE SPECIES GROWN IN CULTURE SOLUTIONS. Handreck, K. A.; Riceman, D. S. (Commonwealth Scientific and Industrial Research Organization, Adelaide). Aust. J. Agr. Res., 20: 213-26(Mar. 1969).

Lucerne (Medicago sativa cv. Hunter River), subterranean clover (Trifolium subterraneum L. cv. Bacchus Marsh), prairie grass (Bromus catharticus Vahl), Phalaris tuberosa, and evening primrose (Oenothera sp.) were grown in culture solutions containing ^{60}Co. The distribution of cobalt in the tops was determined with autoradiographs of pressed, rapidly dried plants and by measuring the total amounts of ^{60}Co in pieces of fresh leaves dissected immediately after harvesting. Cobalt concentrations in the margins of lucerne, clover, and primrose leaves and at the base and extreme tip of the primrose and grass leaves were many times those found in other parts of the leaves. Cobalt accumulated at cut and cropped ends of leaves. Leaching removed up to 75% of the cobalt from dried leaves but none from fresh leaves. The concentration of cobalt in a given lucerne leaf reached a maximum soon after emergence and then declined rapidly as the leaf expanded. (Australia)

38414 ^{14}C TRANSLOCATION IN ORANGE PLANTS. Kriedemann, P. E. (Common Scientific and Industrial Organization, Merbein, Australia). Aust. J. Agr. Res., 20: 291-300(Mar. 1969).

Translocation patterns were studied by supplying $^{14}CO_2$ to selected source leaves under glasshouse conditions and preparing whole plant autoradiographs. The chemical nature of $^{14}CO_2$ fixation products was also examined. Within the actively growing shoots all currently expanding leaves showed strong import of ^{14}C assimilates but no export. Fully expanded leaves, borne either on a fruitful growth cycle or on a previous cycle, exported assimilates principally to nearby fruits. Sharp differences existed between adjacent fruits during their early development with respect to the level of ^{14}C incorporation. Mature leaves some distance from sites of current growth activity exported principally to the root system. Old leaves between the source leaf and roots failed to import. ^{14}C-labeled sugars comprised the bulk of radioactive assimilates in leaf, stem, and fruit 24 hr after the commencement of feeding. In the roots, amino acids were the most heavily labeled fraction. ^{14}C photosynthate appeared to be translocated as sucrose and it was this metabolite which occurred within the outer peel of the fruit. (Australia)

38415 RESPONSE OF SUBTERRANEAN CLOVER (TRIFOLIUM SUBTERRANEUM L.) TO FOLIAR APPLICATIONS OF PHOSPHORUS. Bouma, D. (Commonwealth Scientific and Industrial Research Organization, Canberra, Australia). Aust. J. Agr. Res., 22: 435-45(May 1969).

Subterranean clover plants were grown in river sand or in culture solutions with and without phosphorus. Some phosphorus-deficient plants were sprayed once every 2 to 3 days with solutions pH2.5) of several phosphorus compounds at various concentrations, with and without wetting agents. Dry weights of tops and roots were significantly increased by most spray treatments compared with control plants grown without phosphorus. Foliar applications of 50mM phosphoric acid solutions, containing little or no wetting agent, generally gave the greatest response. In the first experiment the plant dry weight in the best spray treatment was twice as high and in the second experiment 3.5 times as high as in the

controls without applied phosphorus. In these spray treatments plant dry weight was no more than 40% of that in the control treatment receiving root phosphorus. Two days after application of ^{32}P (solution pH 5.5, 0.01 mM phosphate) to the center leaflet of either the first or the fourth trifoliate leaf, 70% of the tracer could be removed by washing with 20 ml water. Seven days after application of the tracer the treated leaflet of the first or the fourth trifoliate leaf still contained 77 or 70% respectively of the amount absorbed by the plant. In another experiment, in which ^{32}P was applied in a 30mM H_3PO_4 solution at pH 2.5 or 5.0, washing of the treated leaflet 2 days after application removed 42 and 60% of the tracer respectively. Seven days after application the treated leaflet contained 28 and 34% respectively of the residue after washing. Relatively slow rates of uptake of phosphorus applied to the leaves were considered to be at least partly responsible for the poor growth responses compared with phosphorus applied to the roots. It was concluded that foliar applications of phosphorus offered little scope as a practical means of hastening the recovery from phosphorus deficiency. (Australia)

38416 STATE OF THE MEDIATOR LINK IN THE NERVOUS SYSTEM GANGLIA IMMEDIATELY AFTER IRRADIATION. Mtskhvetadze, A. V. (Roentgen-Radiological Inst., Leningrad). Soobshch. Akad. Nauk Gruz. SSR, 53: 749-52(Mar. 1969). (In Russian).

Data are presented from a study of the dynamics of acetylcholine metabolism caused by different amounts of functional stimulation of the upper-neck sympathetic ganglion of the cat after x-radiation exposure. (auth)

38417 HL-A ANTIGENS OF HUMAN LYMPHOID CELLS IN LONG-TERM TISSUE CULTURE. Rogentine, G. Nicholas Jr.; Gerber, Paul (National Cancer Inst., Bethesda, Md.). Transplantation, 8: 28-37(July 1969).

Sixteen human lymphoid cell lines were assayed for HL-A antigens using 29 antisera and the ^{51}Cr release cytotoxicity technique. Ten HL-A antigens were identified on these cells. No two cell lines were identical. HL-A antigens were distinguishable from A, B, and Rh D red cell antigens by direct cytotoxicity and by absorption analyses. Antigens of four lines tested were stable for periods of 1 yr and more. These cell lines offer potential for evaluation of unknown alloantisera, absorption of multispecific sera, and for studies of modification of cell surfaces under varying environmental and genetic influences in vitro. (auth)

38418 FACTORS AFFECTING THE ACCUMULATION OF COLLOIDAL ^{198}Au IN LYMPH NODES FOLLOWING SUBCUTANEOUS INJECTION. Shcheglov, S. M. (Moscow Oncological Research Inst.). Med. Radiol., 14: No. 5, 82-5(May 1969). (In Russian).

Experiments were carried out on 120 male rats of different ages having grafted tumors (sarcoma-45 and M-1). A total of 30 to 40 microcuries of radioactive gold in 0.1 ml was introduced intramuscularly into the middle third of each femur. The radioactivity of the lumbar lymphatic nodes was determined on an end-window counter, and that of the liver and femur muscle was determined on a scintillation counter. The liver of healthy control animals contained 4.6 to 6.2% of the injected gold, while the liver of tumor-bearing animals showed 0.17 to 0.65% of the injected gold. The healthy control animals showed 81 to 83% of the injected activity in the femur, while the tumorous animals showed 89 to 94% of the injected activity. The amount of ^{198}Au penetrating the lymphatic nodes decreased with increasing age. Less ^{198}Au penetrated to the lymphatic nodes of the tumor-bearing animals than to those of the healthy control animals. The greater the weight of the tumor, the smaller the penetration of radioactive gold to the lymph nodes. (TTT)

38419 INVESTIGATION OF TISSUE EXTRACTION AND LIQUID SCINTILLATION COUNTING OF TRITIUM IN DRIED WHOLE TISSUE. Cramer, Hinrich; Sprenger, Harry (Univ., Freiburg i. B.). Int. J. Appl. Radiat. Isotop., 20: 377-86 (May 1969). (In German).

The study described investigated the solubility of dried whole tissue in several strong ammonia bases and liquid scintillation counting of tritium in base-containing systems. Complete digestion and low color quenching were obtained with Hyamin, NCS, and Digestin by warming in air-tight vials. The scintillators BBOT, Butyl-PBD, BIBUQ, and PPO + Dimethyl-POPOP in toluene solution were examined as to fluorescence, self-quenching, optimal concentration and tolerance of bases. A remarkable influence of pH on counting efficiency was observed. The bases led to progressive coloring and to shifting of the fluorescence spectra of the scintillators. Treatment with strong acids led to high counting efficiencies and stable counting rates. An external standard was used with good results for the determination of efficiency in routine counting. (auth) (UK)

38420 VARIATIONS IN THE RETENTION AND EXCRETION OF ^{137}Cs WITH AGE AND SEX. Boni, A. L. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nature (London), 222: 1188-9 (June 21, 1969).

A four-year study is described on the biological behavior of ^{137}Cs in 110 people, representing a cross-section of the general population. The body content of ^{137}Cs was measured with a whole-body counter, and urine samples were analyzed for ^{137}Cs and ^{40}K, the combined body counts and urine analyses providing a material balance between assimilation, retention and excretion of ^{137}Cs. The ^{137}Cs content of urine was expressed per gram of K. The monthly average ^{137}Cs body burdens, as measured with the whole-body counter, increased with age, and more rapidly in males than females. The differences were affected by body weight. Potassium content is normally proportional to body weight and is also proportional to age until adolescence; in adults K becomes relatively constant, with the concentration in males 1.6 that in females. For this reason measured body burdens were normalized to K content. The yearly average biological half-time was determined and correlated with age. The average biological half-life was found to be 20 days for both males and females between 5 and 14; it increased abruptly for males at 15 to an average value of 67 days, and appeared to increase further to 93 days between the ages of 30 and 50 years. Data for males over 55 indicated a decrease to 70 days. For females between 15 and 50 the half-life remained relatively constant at 47 days. Mathematical models were derived for the relationship between male and female biological half-life and age. For males there are two distinct components in the relationship—a first degree polynomial up to age 14 and a third degree polynomial of log form from 14 to 75. The relationship for females is a second degree polynomial of log form, since the transition at 15 is not abrupt. The linear correlation curves permit the use of urine analysis to estimate the average body burdens of segments of large populations quickly, inexpensively, and accurately, and the biological half-life curves will permit more accurate assessment of doses on the basis of age and sex. (UK)

38421 DYNAMICS OF ^{241}Am IN THE SKELETON OF THE RAT: A STUDY OF THE RELATIONSHIP BETWEEN BEHAVIOR OF BONE-SEEKING ELEMENTS AND BONE-GROWTH STATUS. Durbin, Patricia W.; Jeung, Nylan; Williams, Marilyn H. (Univ. of California, Berkeley). pp 137-56 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

Behavior of ^{241}Am and ^{45}Ca in the skeleton and growth and senescence of the skeleton of the female Charles River CRCD rat were studied using tracer, histologic, and autoradiographic techniques. Curves of ^{45}Ca in rib, tibia, vertebrae, and mandible (sums of exponentials) contained four components that were related to physiological process: A_1, early loss of diffuse label; A_2, growth remodeling; A_3, slower growth remodeling (rib and mandible) and maintenance remodeling; and A_4, remodeling of cortical bone (uncompensated in extreme old age). Curves of Am retention in tibia and vertebrae consisted only of A_3 and A_4. The rib curve contained A_2, and was constant (or increased slightly) thereafter. The Am curve of mandible was constant (or increased slightly) from the day of injection. Am, and presumably other tri-valent cations, apparently did not participate in exchange reactions in bone as do the alkali metals and alkaline earths. Early loss of Am from bone was attributed to growth remodeling, later release to cortical remodeling and age-related mineral loss from long bones and spine. Am was retained indefinitely (or was slowly accumulated) in bones that experience no net mineral loss in old age, i.e., rib and mandible. In the adult rat, the redistribution trend of Am was toward longer-lived bony structures while that for ^{45}Ca was mainly towards new bone formation in temporary bony structures. Redistribution of part of the skeletal burden prolonged the observed retention according to the relationship $\lambda_{obs} = \lambda_{phys}(1-fr)$, where λ_{obs} is the observed (net) rate of loss, λ_{phys} is the gross loss rate associated with bone remodeling, and fr is the fraction of the released Am recycled to bone. (auth)

38422 PLUTONIUM DEPOSITION ON BONE SURFACES AND IN BONE MARROW FOLLOWING INTRAVENOUS AND INTRAMUSCULAR INJECTIONS. Bleaney, Betty (Churchill Hospital, Oxford). pp 125-35 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

The localized distribution of ^{239}Pu on the bone surfaces and in

the bone marrow was measured in femurs and vertebrae of rabbits given either intravenous (i.v.) or intramuscular (i.m.) injections in nitrate solution at a pH of about 6. The two methods used were counting α-tracks from standard autoradiograms and counting fission tracks in polycarbonate foils from Pu when irradiated by slow neutrons. In weanling rabbits, in spite of extensive growth and remodeling, there was still Pu on the bone surfaces 7 months after i.v. injection. With rabbits that were 7 months old at injection, there was no significant decrease in the Pu on the bone surface with time. With i.m. injection, less Pu went to the bone surface initially, but at later times after injection, preliminary results suggested that the amount of Pu on the bone surface may be of the same order of magnitude as for i.v. injection. A significant amount of Pu went to the marrow. Marrow near trabecular bone on endosteal surfaces was heavily irradiated in both i.v. and i.m. injections. In the shaft of the femur, the marrow dose was lower in an i.m. injection than in an i.v. injection, and there were very few aggregates of Pu up to 7 weeks after injection. These experiments show that in both i.v. and i.m. injections, the endosteal bone surfaces and the marrow were irradiated, and that the Pu can remain either on bone surfaces or in marrow close to bone surfaces for long periods of time. (auth)

38423 ^{239}Pu(IV): ITS DISTRIBUTION IN THE BEAGLE. Stover, Betsy J.; Atherton, D. R.; Bruenger, F. W.; Buster, Dawn S. (Univ. of Utah, Salt Lake City). pp 109-23 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

When it was observed that long-term hepatic retention was greater at lower dose levels than at higher ones, a compensating effect was sought in excretion or skeletal retention or both. The excretion data were analyzed by dose-level and no significant dose-level difference was detected. The retentions in the humerus and the third lumbar vertebra at the P5-level showed no change with time, but comparison of these bones from P5-, P4-, and P3-level dogs showed some significant decreases in fractional retention with decreasing dose-level. Changes in skeletal retention at these dose-levels were estimated as the difference between rate of change of soft tissue retention and excretion. Detailed data describing the variations between dogs, bones, and parts of bones are given. (auth)

38424 KINETICS OF CALCIUM, STRONTIUM, BARIUM, AND RADIUM IN RATS. Domanski, Tomislaw; Liniecki, Julian; Witkowska, Danuta (Instytut Medycyny Pracy, Lodz, Poland). pp 79-94 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

The rapidly exchangeable pool of calcium (E) and the bone accretion rate (A) were determined in adult rats using ^{45}Ca, ^{85}Sr, ^{133}Ba, and ^{226}Ra as tracers. Values of both parameters for Ba and Ra were six to eight times those for Ca, whereas for strontium and calcium (A) and (E) were similar. Urinary clearance rates from plasma of Sr, Ba, and Ra were higher than that of Ca by factors of 5, 18, and 35, respectively. Clearance rates for endogenous fecal excretion of Sr were close to those for Ca, whereas for Ba and Ra they were 7 and 24 times greater, respectively, than for calcium. Implications of the above findings for the long-term retention of Sr, Ba, and Ra are briefly discussed. (auth)

38425 METABOLIC, DOSIMETRIC, AND PATHOLOGICAL CONSEQUENCES IN THE SKELETONS OF BEAGLES FED ^{90}Sr. Goldman, M.; Della Rosa, R. J.; McKelvie, D. H. (Univ. of California, Davis). pp 61-77 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

Metabolic factors associated with uniform labeling of skeletons of several hundred beagles fed ^{90}Sr from mid-gestation to 1.5 yr of age are summarized. The placental and mammary barriers resulted in a reduction of ^{90}Sr concentration in young pups. The concentration changed rapidly with consumption of a diet containing ^{90}Sr. At adulthood the ^{90}Sr/Ca in the labeled skeleton was 0.4 that of the diet. The six levels used in the diet ranged from 0.03 to 12 μCi ^{90}Sr/day, with maximal skeletal dose-rates of 0.5 rad/μCi ^{90}Sr/day. Body burdens were about 10 times the daily feeding rate. Excreta and plasma ^{90}Sr decreased exponentially after dosing, with a $T_{\frac{1}{2}}$ of 5 to 7 yr primarily due to the slow turnover of cortical bone, which contains most of the skeletal mineral. Strontium-90 may cause a decrease in skeletal circulation pattern as seen by ^{18}F positron camera survey. There was little radiographic evidence of ^{90}Sr injury at 5-yr of age, but at necropsy bone appeared hardened and was difficult to fracture. Microradiographic examination demonstrated cortical thickening, smaller medullary cavities, and fewer remodeling osteons. All of these manifestations suggest a severe impairment of normal bone remodelling. Although no osteosarcomas were noted, the colony is still too young for complete bone cancer evaluations. (auth)

38426 STRONTIUM RETENTION IN MAN. Mueller, Jan; Thomas, Josef (Inst. of Radiation Hygiene, Prague). pp 51-9 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

About 60 persons exposed to ^{90}Sr dial paint during the interval 1 January 1957 to 15 March 1958 were examined. In nine dial painters whose present body burdens exceeded 0.1 μCi of ^{90}Sr, excreta analyses indicated $b_1 \pm$ S.E. $= 0.412 \pm 0.072$ for the middle phase (900 to 2600 days after mid-contamination). John Marshall (J. Theor. Biol. 6: 386-412, 1964) has developed a modified power function for the biological retention (R) of an alkaline earth element at (t) days after injection: $R = \epsilon^b (t + \epsilon)^{-b}$ where (b) and (ϵ) are constants, and ($t \leq t_y$). After equilibrium time (t_y), retention is presumed to follow a single exponential. Bishop et al. (Int. J. Radiat. Biol. 2: 125-142, 1960) evaluated the biological retention and excretion of ^{85}Sr during the first year after its injection into two healthy men. Fitting the modified power function to their data gives $b_1 \pm$ S.E. $= 0.283 \pm 0.009$ and $\epsilon_1 \pm$ S.E. $= 0.213 \pm 0.040$ for the early phase (0 to 365 days after injection). Combining the ^{85}Sr and our ^{90}Sr results, $b \pm$ S.E. $= 0.304 \pm 0.013$ and $\epsilon \pm$ S.E. $= 0.259 \pm 0.077$. The terminal biological half-time (T) for the late phase of retention was estimated at T ± S.E. = 9020 ± 1090 days from data on stable Sr, the assumption that intestinal absorption $f_1 = 20\%$ for Sr, and the parameters (b) and (ϵ). The corresponding equilibrium time $t_y \pm$ S.E. $= 3960 \pm 590$ days. Thus the indicated biological retention for injection (or absorption) of Sr into adult humans is:

$$R = \begin{cases} 0.66\ (t + 0.26)^{-0.30} & \text{for } t \leq 4000 \text{ days} \\ 0.072\ e^{-0.693\ t/9000} & \text{for } t \geq 4000 \text{ days} \end{cases}$$ (auth)

38427 RETENTION AND ABSORPTION OF ^{224}Ra AND ^{234}Th AND SOME DOSIMETRIC CONSIDERATIONS OF ^{224}Ra IN HUMAN BEINGS. Maletskos, Constantine J. (New England Deaconess Hospital, Boston. Harvard Medical School, Boston); Keane, Albert T.; Telles, Norman C.; Evans, Robley D. Contract AT(30-1)-952. pp 29-49 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

When normal elderly human subjects (aged 63 to 83 yrs) ingested mock radium dial paint containing $^{224}RaSO_4$, $^{234}Th(SO_4)_2$, $BaSO_4$ carrier, and ZnS phosphor, the intestinal absorption was about 20% for ^{224}Ra but only 0.02% for ^{234}Th. Thus, ^{228}Th in real dial paints is unlikely to have contributed a significant radiation dose (≤5%) to bone of those subjects who ingested such paint. Similar subjects were injected intravenously with ^{234}Th citrate in isotonic citrate or with ^{224}Ra chloride in isotonic saline. The excretion of ^{234}Th was low, with the urine-to-feces ratio of 12 for males and 24 for females. It appeared from the 100 day observation time that about 93% of the injected ^{234}Th would be retained with a biological half-period >5 years. The excretion of injected ^{224}Ra was high, with a feces-to-urine ratio of 30. During the 20 day observation time, biological retention of Ra can be expressed as $R(\%) = 84\ e^{-0.366\ t} + 16$. These results are in agreement with those of Mays et al. and Harrison et al., and they all tend to be higher during the first few days than the retention function of Norris et al., $R = 54\ t^{-0.82}$, and Miller and Finkel, $R = 30\ t^{-0.44}$. Measurements in man indicate that soft-tissue Ra retention is high. This finding, combined with the whole-body biological retention, points to a skeleton retention that may be as low as 10% of the injected dose and relatively constant in the first few weeks. Average adult skeletal radiation dose estimates vary between reasonable limits of 0.05 to 0.5 rad/μCi ^{224}Ra injected. The median value is 0.25 rad/μCi and a probable value is 0.15. For children the estimated average skeletal dose ranges from 0.3 to 0.9 rads/μCi multiplied by the factor of (70 kg/body weight of child) to account for their smaller weight. (auth)

38428 RETENTION OF RADIONUCLIDES IN BONE. Marshall, John H. (Argonne National Lab., Ill.). pp 7-27 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

A simple description of the mechanisms of radionuclide retention, together with their relevance to radiation toxicity, separates

bone seekers into two classes: surface seekers and volume seekers. An explanation for the increased endosteal as compared with periosteal uptake of plutonium is offered in terms of the centrifugal pattern of blood flow in bone. The marrow deposition of polymeric plutonium, the short-term exchange of the alkaline earths on bone surfaces, and the self-burial of radium hotspots is discussed. The diffuse component and power function retention are explained in terms of a slow radial diffusion of alkaline earth ions in canalicular territory. An unusual case of enhanced resorption in a radium case is discussed. If in an adult man one were to postulate that the proliferating preosteoblasts (which are only found near growing bone surfaces) were the principal cells for osteosarcoma induction, then these cells would have to be at least an order of magnitude more sensitive than the cells near resting bone surfaces. In adult bone it seems more likely that it is the alpha particle energy that escapes from all bone surfaces that produces osteosarcomas. (auth)

38429 DELAYED EFFECTS OF BONE-SEEKING RADIONUCLIDES. Proceedings of an International Symposium Held at Sun Valley, Idaho, September 12-14, 1967. Mays, Charles W.; Jee, Webster S. S.; Lloyd, Ray D.; Stover, Betsy J.; Dougherty, Jean H.; Taylor, Glenn N. (eds.). Salt Lake City, University of Utah Press, 1969. 533p. $17.50. (CONF-670938).

Separate abstracts were prepared on 26 of the 27 papers in this symposium. The other paper appeared previously in NSA. The papers are arranged in six sections including: retention of bone-seeking elements, distribution of plutonium and americium, cancer induction in humans, soft-tissue neoplasms, bone cancers, and additional biological effects. Author and subject indexes are included. (E.R.B.)

For abstracts of individual papers see: 38421-38428, 38586, 38587, 38794-38806, and 38852-38854.

38430 AUTORADIOGRAPHIC STUDY OF RIBONUCLEIC ACID SYNTHESIS DURING SPERMATOGENESIS OF ASELLUS AQUATICUS (CRUST. ISOPODA). Brasiello, Angela Rocchi (Univ., Rome). Exp. Cell Res., 53: 252-60(Oct. 1968).

By means of autoradiography, a study was made of the incorporation of ^{3}H-uridine in the cells of the testicle of Asellus aquaticus. Ribonucleic acid synthesis was observed in all the cells during the whole mitotic cycle except in metaphase and in anaphase. The meiotic prophase incorporated RNA with different intensities in the various stages, with a maximum in late pachytene. Meiotic metaphase and anaphase are not incorporated at all. The first labeled spermatids are observed only four days after the administration of the radioisotope. The spermatozoa showed labeled tails from the seventh day onwards. The nurse cells showed in great number, a heavy nuclear labeling from the first few minutes and maintained until the 16th day. About 7 hr after the injection, the cytoplasm of all the cells began to be slightly labeled. It is probable that there exists, in addition to a massive passage of RNA from the nucleus to the cytoplasm, at metaphase a slow passage during all stages of the cellular cycle. (auth)

38431 STUDIES OF DIET AS A FACTOR IN ^{137}Cs METABOLISM BY RATS. Snipes, Morris B.; Riedesel, Marvin L. (Univ. of New Mexico, Albuquerque). J. Nutr., 97: 212-18(Feb. 1969).

Rats fed semistarvation, high carbohydrate, high protein, and high fat diets retained more ^{137}Cs than control animals 7 days after intraperitoneal injection of a single dose of the isotope. The primary effect of diet on cesium metabolism may have been modification of cesium excretion via urine and feces. There appeared to be a direct relationship between mass of fecal material and the amount of ^{137}Cs excreted in feces. Apparently diet variation changed the composition and amount of material in the intestinal lumen to which cesium could be adsorbed for subsequent excretion in feces. On the other hand, cesium excretion via urine seemed to be less dependent on the amount of urine produced. Varying the primary nutrients by feeding rats high protein, high carbohydrate or high fat diets resulted in increased or decreased affinity of some cells for cesium. These results are not readily explainable but may be caused by shifts in the relative amounts of connective tissue present in the tissues studied. (auth)

38432 DEPOSITION OF URANIUM IN BONE. Rowland, R. E.; Farnham, J. E. (Argonne National Lab., Ill.). Health Phys., 17: 139-44(July 1969).

Quantitative autoradiography was employed to study the distribution of two isotopes of uranium in the bones of dogs. ^{232}U or ^{233}U was injected intravenously as the nitrate into adult dogs, and the animals were sacrificed serially at times ranging from 2 to 72 days after injection. The femora and tibia were taken at the time of sacrifice for autoradiographic analysis. The results showed that at 2 days after injection the uranium had a distribution pattern very similar to that seen with plutonium, i.e., it was localized on bone surfaces. By 6 days, however, a diffuse distribution of this element was present. Seventy-two days after isotope administration the distribution pattern was remarkably like that of calcium, with intense hot spots over the growth regions and a diffuse distribution throughout all of the pre-existing bone. (auth) (UK)

38433 ELECTRON MICROSCOPIC EXAMINATION OF DIFFUSION AND RESORPTION OF THORIUM DIOXIDE IN THE COCHLEA OF THE GUINEA PIG. I. SPIRAL LIGAMENT AND STRIA VASCULARIS. Iiberg, Christoph V. (Univ., Frankfurt am Main). Arch. Klin. Exp. Ohren-, Nasen-, Kehlkopfheilk., 190: 415-25(1968). (In German).

The diffusion and resorption of ThO_2 in the spiral ligament and stria vascularis were studied following injection into the perilymphatic and endolymphatic spaces of the guinea pig ear. It was shown that the injected ThO_2 freely diffused from the scala tympani to the scala vestibuli. The cells of the spiral ligament lining the scala vestibuli and scala tympani proved to be no barrier for Thorotrast particles thus the 2 scalae and the spiral ligament formed a single space filled with perilymph. No trace of ThO_2 particles was found in between the cells of stria vascularis. The epithelial cells of the stria vascularis at the scala media side showed a high reabsorption activity of the ThO_2 particles by means of pinocytosis. The absorption activity of the basal cells of the stria vascularis was less marked. The capillaries in the stria vascularis and those in the spiral ligament did not absorb the ThO_2. (BBB)

38434 IODINATION OF PROTEINS OF THE HUMAN THYROID (NORMAL AND PATHOLOGIC). Etling, N.; Martin, A.; Vallee, G.; Lachiver, F. Acta Endocrinol., 59: 545-54(1968). (In French).

The radioiodine distribution between the different soluble thyroid proteins was studied after ^{125}I administration, in normal human thyroid tissues and in several pathological tissues, by sucrose gradient ultracentrifugation. In the normal humans, the most part of the radioactivity is bound to 19S thyroglobulin, and also, for a small percentage, to 12S and 27S proteins. The repartition seems similar from two hr to seven days after isotope administration. The stable iodine proportion bound to the proteins precipitating between 35 and 50% of ammonium sulfate saturation is almost the same as the radioiodine percentage precipitating in the same zone. In the pathological thyroids, the radioactivity distribution between the 12, 19, and 27S proteins gave normal results in toxic adenoma, simple goiter, and in a tumor, but were different from normal results in a case of Hashimoto thyroiditis. (BBB)

38435 ^{47}Ca KINETIC STUDIES IN THE DOG. INTRINSIC VARIABILITY UNDER STANDARD CONDITIONS; EFFECTS OF THYROPARATHYROIDECTOMY; EFFECTS OF PARATHORMONE AND TRIIODOTHYRONINE. Green, William T. Jr.; Watts, Hugh G.; Panagakos, Panos; Oh, Won; Wilson, Richard E.; Banks, Henry H. (Peter Bent Brigham Hospital, Boston). Clin. Orthop. Related Res., No. 61, 154-63(Nov.-Dec. 1968).

The reproducibility of the Ca kinetic technique as studied with ^{47}Ca and the effects of parathyroid removal and parathormone injection on ^{47}Ca metabolism were studied in dogs. Dogs on a standard diet providing 2 to 3 g Ca/day or dogs fed a Ca-free diet for 10 days were injected intravenously with 10 to 15 μCi/kG body wt ^{47}Ca. Blood, urine, and fecal samples were collected 1 hr to 1 week later. There was marked variability in the size of the Ca exchangeable pool and the ^{47}Ca accretion rate between animals and in the same animal. The size of the exchangeable Ca pool decreased over a 6-month period after thyroparathyroidectomy. The ^{47}Ca accretion rate dropped rapidly after the operation. Changes induced by the administration of parathormone and triodothyronine were variable and unpredictable but there was a tendency for both hormones to enlarge the pool of exchangeable Ca and increase the ^{47}Ca accretion rate. The results indicated that Ca in the intestinal tract was a part of the body Ca pool and required modifications of the kinetics model used. (BBB)

38436 DISTRIBUTION OF PHOSPHOUR (^{32}P) IN VARIOUS ORGANS AND TISSUES OF NORMAL AND AUDIOGENIC RATS. Tsvetkova, V. V.; Rasin, S. D. (Bogomoletz Inst. of Physiology, Kiev). Fiziol. Zh., Akad. Nauk Ukr. RSR, 14: 395-8(May-June 1968). (In Ukrainian).

Data are tabulated on the distribution of 20 μCi of ^{32}P in pancreas, nerve tissue, bones, muscles, and spinal cord in normal and audiogenic rats. (R.V.J.)

38437 UPTAKE AND LOSS OF RADIONUCLIDES BY THE FRESHWATER CLAM LAMPSILIS RADIATA (Gmel.). Harvey, R. S. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Health Phys., 17: 149-54(July 1969).

The uptake and loss of radionuclides by the freshwater clam

Lampsilis radiata (Gmel.) were studied under natural stream conditions at the Savannah River Plant. The species was found to be a good biological indicator of plant-released radionuclides. Specimens in a reactor effluent stream were exposed to very low concentrations of ^{144}Ce, ^{137}Cs, ^{90}Sr, ^{65}Zn, ^{60}Co, ^{54}Mn, ^{51}Cr, and ^{35}S for 91 days, and then transferred to a nonradioactive stream for retention studies. Except for ^{90}Sr, all of the radionuclides studied were concentrated in the soft tissues; only ^{90}Sr, ^{54}Mn, and ^{137}Cs were concentrated significantly in the shells. At apparent equilibrium, concentration factors for soft tissues were 220 for ^{137}Cs, 240 for ^{35}S, 440 for ^{51}Cr, 790 for ^{60}Co, 900 for ^{144}Ce, 2400 for ^{54}Mn, and 4100 for ^{65}Zn. The retention study showed that the biological half-life of each radionuclide in the soft tissues consisted of both short and long-lived components (days): ^{144}Ce (2.0, 34), ^{137}Cs (3.0, 38), ^{65}Zn (3.5, 40), ^{35}S (4.8, 44), ^{51}Cr (5.0, 52), ^{54}Mn (2.8, 81), and ^{60}Co (4.8, 277). Short-lived components represented 34 to 61% of the radioactivity in soft tissues. (auth)

38438 HTO-FORMATION FROM TRITIUM-LABELED SUBSTANCES IN VIVO AS A PROOF OF TRITIUM INCORPORATION. Wenzel, Martin (Freie Univ., Berlin). Aerztl. Forsch., 19: 648-51(Apr. 1969). (In German).

Formation of tritiated water from the degradation of ^{3}H-labeled compounds was followed in rats for up to 30 hr. HTO accounted for 60 to 90% of the label within 10 hr after injection of uridine-5-T, glucose-6-T, glucose-1-T, glutamate-2-T, testosterone-17α-T, and estradiol-17α-T; 30% of thymidine-T; 10% cortisol-11α-T; and 5% of testosterone-7-T. The animals excreted tritium in the urine as HTO mostly during the first 24 hr following tritium incorporation from nonvolatile tritium-labeled compounds. In pregnant rats the formation of HTO from uridine-5-T was remarkedly reduced, indicating intensified incorporation of uridine in RNA. Using ascites tumor cells as a model, the incorporation of tritium in single cell fractions during incubation in lactate-2-T, glycerol-2-T, and glucose-1-T was studied. As a practical matter for the problem of radioprotection in handling tritium it is recommended that the activity in the urine be monitored. (BBB)

38439 COMPARATIVE STUDY OF THE EFFECTS OF THE DUST OF BORIDES AND CARBIDES OF TRANSITION METALS ON THE HUMAN ORGANISM WITH REGARD TO THEIR ELECTRONIC CONFIGURATION. Brahnova, I. T. Gig. Tr. Prof. Zabol., 13: 26-31(Jan. 1969). (In Russian).

Animal experiments to determine the effect of TiB_2, ZrB_2, and CrB_2 dusts compared with that of amorphous boron particles and metal components of these borides, and with that of carbide dusts (B_4C, TiC, ZrC, and Cr_3C_2) are reported. The boride dusts, like the carbide dusts, have a more or less pronounced fibrogenic and toxic effect. The borides studied proved more toxic than the carbides. A certain correlation between the toxicity of these substances and their electronic structure was established. The toxicity of borides and carbides decreases in inverse ratio to the statistical weight of the configurations of stable electrons and in direct proportion to the energetic stability of the electron configurations. (Occup. Safety and Health Abstr.)

38440 SUPPRESSION OF ANTIBODY FORMATION BY THE RES BLOCKADE. II. EFFECTS OF THE RES BLOCKADE WITH RADIOACTIVE GOLD COLLOID. Ohbuchi, Shinji (Okayama Univ. Medical School, Japan). Acta Med. Okayama, 22: 113-22 (Apr. 1968).

The effect of irradiation of macrophages of the reticuloendothelial system (RES), after phagocytosis of colloidal ^{198}Au, on subsequent plasma cell proliferation and antibody formation was studied. Radiogold injected intravenously was selectively trapped by the Kupffer cells of the liver, sinus-lining and reticular cells in spleen and lymph nodes, and reticular cells in bone marrow, with a marked atrophy of lymph follicles in spleen and lymph nodes and suppressed granulopoiesis in bone marrow. Erythropoiesis was not severely arrested but red cells were readily hemolyzed and phagocytized by the RES. Reflecting the histological and cellular changes, lymphopenia and granulocytopenia with moderate anemia were observed in the circulating blood. The RES cells of liver and spleen were heavily loaded with the radiogold particles and an impaired clearance rate resulted, though the RES cells appeared not to be damaged morphologically. Evidently, it is difficult to destroy macrophages completely by giving radioactive metals. But lymphocytes, because of their high radiosensitivity, disappeared from the effects of the radiogold trapped by the RES. Antigenic challenge of these animals revealed markedly lowered antibody formation. The atrophied lymph follicles did not become hypertrophic either in spleen or lymph nodes even 10 days after booster injection, but plasma cells appeared in the medullary cords of lymph nodes and probably this plasmacytic reaction was the source of antibody formation. (BBB)

38441 RESPONSES OF BEAN PLANTS TO ROOT TEMPERATURES. IV. TRANSLOCATION OF ^{22}Na APPLIED TO THE LEAVES. Brouwer, R.; Levi, E. (EURATOM-ITAL, Wageningen, Netherlands). Acta Bot. Neer., 18: 58-66(Feb. 1969).

The foliar uptake and subsequent transport in bean plants of ^{22}Na, ^{32}P, and ^{134}Cs was studied under controlled environmental conditions at varying root temperatures. Bean plant (Phaseolus vulgaris) seedlings were kept at root temperatures ranging from below to above the optimum for bean plants. An aqueous solution containing 0.1 μCi of ^{22}Na or ^{134}Cs in 1 mM carrier of the chloride salts, or ^{32}P as NaH_2PO_4, was applied to the tip of one primary leaf 3 days after transplanting. Radioactivities taken up by the plants, held in the treated areas, distributed in various plant fractions, or excreted through the roots were determined for 6 days. Uptake of ^{22}Na was slower than that of ^{134}Cs but much faster than that of ^{32}P. Root temperature strongly influenced the rate of uptake of the isotopes, with an optimum range between 20 and 25°C. Penetration was found to be more affected by the root temperature during the pretreatment period than by that during the experimental period itself. Translocation and distribution during the first 6 hr were also influenced by the pretreatment temperature of the roots. Leakage of ^{22}Na and ^{134}Cs into the solution around the roots was found to occur at all temperatures. (BBB)

38442 METABOLIC STUDIES WITH ^{65}Zn. IX. ZINC IN GUINEA PIG HAIR. Iranzo, E.; Chueca, A.; del Amo, C. G.; Santos-Ruiz, A. (Univ., Madrid). Rev. Espan. Fisiol., 25: 93-100(June 1969). (In Spanish).

The accumulation and elimination of ^{65}Zn in the skin and hair of the guinea pig were studied. The concentration of ^{65}Zn in the hair increased from the time of its administration via the intraperitoneal route until the 24th day at which time the maximum value was reached, 0.48% of injected ^{65}Zn per g of hair, following 2 exponential functions. From the time of injection until the 6th day ^{65}Zn accumulation could be expressed by: $Y_1 = 0.03e^{0.3425t}$, and from the 6th to the 24th day in accord with: $Y_2 = 0.14e^{0.0669t}$. After the 24th day and until the 70th day the ^{65}Zn concentration decreased following the function: $Y_3 = 1.1e^{-0.0298t}$. Zinc-65 concentration in the skin reached a maximum on the 15th day, 0.22% of injected ^{65}Zn per g of skin. From that day it decreased following the function: $Y = 0.59e^{-0.0661t}$. A biological half-life of 10.5 days was calculated. Females had higher hair ^{65}Zn concentrations than males, but curves for its accumulation and elimination ran parallel. The equation representing the decrease period showed a biological half life of 142 days. The percentage of the ^{65}Zn total-body burden which is in the hair and skin increased over the first 30 days depending on the function: $Y_1 = 12.8e^{0.0254t}$. From this time and to the end of the experiment it followed the equation: $Y_2 = 30.5e^{0.0008t}$. (BBB)

38443 INVESTIGATION OF THE INTERACTION OF URANIUM WITH SOME BIOCOMPLEXONS. Chevari, S.; Likhner, D. (Medical Dept. of the Mining Industry, Mechek, Hungary). Med. Radiol., 14: No. 7, 28-34(July 1969). (In Russian).

The results obtained in the determination of the complex-formation of uranium and the stability of the compounds forming with C_{17}, RNA, and DNA amino acids, as well as with albumin-protein, are given. The data derived may be utilized for the exact selection of substances accelerating the elimination of uranium from the human organism. (auth)

38444 INFLUENCE OF INCOMPLETE ANTIBODIES ON ERYTHROCYTE PERMEABILITY WITH THE AID OF ^{51}Cr. Levin, V. I.; Gorel'chik, K. I.; Svirnovskii, A. I.; Danilov, I. P. (Belorussian Scientific-Research Inst. of Hematology and Blood Transfusion, Minsk). Med. Radiol., 14: No. 7, 71-3(July 1969). (In Russian).

Tabulated data showed that sensitization of erythrocytes by antibodies increased the uptake of ^{51}Cr by erythrocytic cells. The experiments confirmed that the presence of antibodies on the surfaces increased their fixation of ^{51}Cr. The use of ^{51}Cr in a form of $Na_2{}^{51}CrO_4$ anion is suggested as tracer in studies of red blood corpuscle penetrability. (R.V.J.)

38445 THE FATE OF THORIUM DIOXIDE INJECTED INTO THE COELOM OF THE SIPUNCULID, GOLFINGIA CAPENSIS. Brown, A. C.; Winterbottom, R. (Univ. of Cape Town, Rondebosch, S. Afr.). J. Invertebr. Pathol., 13: 229-34(Mar. 1969).

The elimination of thorium dioxide, in the form of Thorotrast, from the coelomic fluid of Golfingia capensis was studied by radiographs, sections, and coelomic fluid samples. Radiographs taken 2 hr after injection showed a uniform distribution of Th throughout the coelom. This was true also 6 hr after injection. However, after 12 hr the Th appeared to be more concentrated toward the posterior end of the body and in the nephridia. The difference in shadow intensity between the posterior region and the rest of the coelom became more marked with time. Transverse

sections through animals killed 12 hr after injection showed free Th particles in all parts of the main body coelom, but particularly in the posterior region. Some Th particles were also seen inside amoebocytic coelomocytes in this region. The peritoneum also showed Th particles within the cells. Cavities of the tentacles and of the compensation sac, that communicate with one another, but not with the main body coelom, contained a few Th-laden amoebocytes but apparently no free Th particles. The rate of elimination was slower than that in any other animal so far subjected to the same technique. All the coelomocyte types phagocytized Th particles. Routes of elimination included the nephridia and gut, and possibly the tentacles. (BBB)

38446 THE RADIOIODINE (^{131}I) CONVERSION RATIO AND PROTEIN-BOUND IODINE IN ATHEROSCLEROSIS. Janotka, M.; Ondrejicka, M.; Pechan, J. (Comenius Univ., Bratislava). J. Atheroscler. Res., 7: 771-6(1967).

Radioiodine metabolism was studied in 124 euthyroid normal patients and 53 euthyroid patients with atherosclerosis, using the conversion ratio and plasma protein-bound iodine (PBI). The ^{131}I conversion ratio was found to decrease with advancing age in both the normal and atherosclerotic groups, but it was much more marked in the atherosclerotic patients, the difference from the normal group being significant. This correlates with the previous finding of a decrease in the ^{131}I uptake capacity of the thyroid gland. The PBI was found to be within the normal range in both elderly normal people and atherosclerotics, although it was slightly lower in the latter group. The discrepancy between the reduced conversion ratio and the normal PBI in old age and atherosclerosis is discussed. The decreased thyroid hormone requirement of the peripheral tissues in ageing may cause a temporary increase in the circulating thyroid hormone level and consequently a rise in the PBI level above its normal value. The elevated PBI, by the feedback mechanism, will cause an inhibition of TSH secretion and thus a decrease in thyroid function. The reduced production of thyroid hormones will then allow the PBI to return to its normal level. (BBB)

38447 THE INFLUENCE OF STABLE STRONTIUM ON THE METABOLISM OF ^{90}Sr AND CALCIUM IN THE GROWING RAT. Lang, K.; Schmidt, B. (Johannes-Gutenberg-Univ., Mainz). Ger. Med. Mon., 14: 89-90(Feb. 1969).

Stable Sr as chloride, 4 to 40,000 ppM, was added to the feed of growing rats daily in addition to 1800 pCi ^{90}Sr/g Ca. The rats receiving the highest amount survived for only 10 days. At 4000 ppM Sr daily there were definite changes in the general state of the animals (amount of food ingested; weight gain), in the radiographs (bone destruction) and in mineral metabolism. About 15% of the added Sr (4000 ppM) was absorbed, 10 to 16% was excreted in the urine, and 4 to 5% retained in the skeleton. About 30 to 40% of the Ca was absorbed and this percentage was not significantly changed by adding Sr. The proportion of Ca replaced from the skeleton by Sr was eliminated by the kidney. While control animals incorporated 23 to 25% of the daily Ca intake into the skeleton, the proportion fell to 20% when Sr was added (4000 ppM). The urinary excretion was increased from 4 to 6% of the Ca offered. About 15% of the daily ^{90}Sr dose (1800 SU) were reabsorbed. Adding stable Sr (4000 ppM) only slightly reduced this amount. The incorporation of the isotope was, however, decreased by almost $\frac{1}{3}$. The displaced ^{90}Sr increased the serum level and was excreted in urine in increased amounts, 9 to 10% instead of 8%. Retention in the skeleton was reduced from an incorporation rate of 5 to 6% ^{90}Sr to 3 to 5%. The consequences of massive Sr intoxication through the addition of 4000 ppM Sr were unfavorable in this form of decontamination. Since with even a dose of 40 to 400 ppM, which is in the biological range, damage may occur without evidence of significant decontamination, this pathway does not seem likely to cause liberation of ^{90}Sr from the skeleton. (BBB)

38448 ACCUMULATION OF ^{99m}Tc IN RAT THYROID. Kapitola, J.; Schuellerova, Marie (Charles Univ., Prague). Endocrinol. Exp., 3: 17-21(1969).

The influence of dessicated thyroid and thyrotropin (TSH) on the uptake of ^{99m}Tc by the thyroid in rats was studied and compared to that of ^{131}I under similar conditions. Immediately after intravenous injection, ^{99m}Tc was found in the thyroid, the maximal radioactivity being found after 15 min (0.039% of the administered dose per mg). Later, the radioactivity decreased and after 240 min it was 0.016%/mg. With ^{131}I the maximum of radioactivity was found as early as 5 min after intravenous injection. Later, the radioactivity decreased and after 120 min only 0.014%/mg was found. In intact groups the accumulation of ^{99m}Tc was 10 times higher after feeding normal diet than after feeding diet containing dessicated thyroid. In rats fed a normal diet, TSH did not affect the accumulation of ^{99m}Tc. In rats fed dessicated thyroid, however, ^{99m}Tc accumulation was not significantly increased after TSH injection 12 hr but was significantly increased after 24 hr. These experiments show that accumulation of ^{99m}Tc by the thyroid is relatively fast, but slower and more protracted than that of radioiodide in the methylthiouracil-blocked thyroid. The final accumulation of ^{99m}Tc in the intact thyroid is very similar to the trapping of ^{131}I in blocked thyroid, indicating that ^{99m}Tc might be successfully used to study various processes involved in the inorganic phase of iodine metabolism in the thyroid. (BBB)

38449 DIELECTRIC PROPERTIES OF OXYHEMOGLOBIN AND DEOXYHEMOGLOBIN IN AQUEOUS SOLUTION AT MICROWAVE FREQUENCIES. Von Casimir, W.; Kaiser, N.; Keilmann, F.; Mayer, A.; Vogel, H. (Technische Hochschule, Munich). Biopolymers, 6: 1705-15(1968).

The complex dielectric constant of aqueous hemoglobin solution was measured at 9.5 GHz. A microwave technique allowing phase and attenuation settings with an accuracy of 0.3° and 0.03 db was used. The shift of the relaxation wavelength and the hydration values of horse hemoglobin were determined for native and lyophilized hemoglobin solution and erythrocytes suspensions as well. The isotope effect of light and heavy water on these parameters was detected. The influence of buffers was studied. Relative measurements, with the sensitivity increased by a factor of 20, were made with alternatingly oxygenated and deoxygenated human hemoglobin solutions. The oxygenation of hemoglobin was found to leave the hydrated molecule volume n-variant within ±250 $Å^3$, while a shift of the relaxation wavelength of 0.0025 ± 0.0015 cm occurs for a hemoglobin concentration of 107 g/l. The results are discussed in terms of the structure and function interrelationship of hemoglobin and the current picture of water structure. (auth)

38450 DISTRIBUTION AND EXCRETION OF VARIOUS MERCURY COMPOUNDS AFTER SINGLE INJECTIONS IN POULTRY. Swensson, Ake; Ulfvarson, Ulf (Karolinska Sjukhuset, Stockholm). Acta Pharm. Toxicol., 26: 259-72(1968).

The excretion and distribution of ^{203}Hg after a single injection of ^{203}Hg, as mercuric nitrate, methylmercury hydroxide, phenylmercury hydroxide, and methoxyethyl mercury hydroxide, was investigated in white Leghorn cocks by means of the scintillation technique. The amount of ^{203}Hg given to the animals varied according to the acute toxicity of the different Hg compounds, and was calculated to correspond to about $\frac{1}{5}$ of LD_{50} of each compound. The excretion of ^{203}Hg was followed each day after the injection until the 20th day. On the 10th day, half of the animals were killed and the organs taken for analysis of radioactivity. On the 20th day the remaining animals were killed and examined in the same way. The ratio between the ^{203}Hg concentrations in the different organs was found to be fairly constant at both times after the injection. However, phenylmercury hydroxide was eliminated less rapidly from the kidneys than from other organs. For all investigated Hg compounds except methylmercury hydroxide it was found that the concentration of ^{203}Hg was highest in liver and kidneys, and much lower in other parts of the body. For methylmercury hydroxide, on the other hand, ^{203}Hg was rather evenly distributed in the body, in agreement with what was previously found in rats. The ^{203}Hg from mercuric nitrate, phenylmercury hydroxide, and methoxyethyl mercury hydroxide was excreted at about the same rate, with a rate constant of about 10^{-4} $(\mu g/Kg)^{-1}$ day^{-1}, while methyl mercury hydroxide was excreted at a much slower rate, the rate constant being about 4×10^{-6} $(\mu g/Kg)^{-1}$ day^{-1}. (BBB)

38451 CONTRIBUTION TO THE DEMONSTRATION OF BONE LESIONS USING ^{85}Sr. Prokopec, J.; Vacek, J.; Musil, J.; Krajska, V. (Charles Univ., Prague). Zentralbl. Chir., 92: Suppl., 1648-58(1967). (In German).

Distribution of ^{85}Sr was measured in patients with normal bone fractures, senile osteoporotic fractures, bone tumors, bone metastases, lymphogranulomatoses, Paget's disease, and Kahler's disease. Measurements were extended for 144 hr after ^{85}Sr administration. The dose of ^{85}Sr used ranged from 7 to 50 μCi. After administration of 50 μCi the skeletal irradiation dose amounted to ~0.8 R, and the whole-body dose was estimated to be ~0.34 to 0.55 R. The uptake of ^{85}Sr by the skeleton did not indicate the nature of the pathological process detected, but it was valuable because it indicated definite areas of intensive osteoplastic or osteoclastic activity. (BBB)

38452 SENSITIVITY OF CHICK EMBRYO TO RADIOACTIVE PHOSPHORUS-^{32}P. Koeteles, G. J.; Antoni, F.; Szabo, L. D. (National Research Inst. for Radiobiology and Radiohygiene, Budapest). Int. J. Radiat. Biol., 15: 245-58(1969).

The development of the chick embryo has been studied as a function of ^{32}P activity level injected into the egg. 50, 100, and 200 μCi of ^{32}P proved to be lethal, 10 or 25 μCi did not inhibit the

development of the embryo; however, even these latter doses reduced the hatching rate by about 30% if the radionuclide was injected on the third day of incubation. Embryonic death is preceded by an appreciable retardation in weight. The extent to which the biological effects should be attributed to the absorption by the embryo of the radiation emitted by the injected radionuclide when decaying and/or to the transmutation of the radionuclide was examined. The distribution of the injected radionuclide within the egg, and radioisotope concentration in the embryo and its surroundings were studied. In addition, the radiation dose absorbed by the embryo at different ^{32}P levels was measured in chick embryo models by chemical dosimetry. The dose–effect relations so obtained prove that ^{32}P transmutation plays an appreciable role in inducing the biological effects in the course of the embryonic developments of higher organisms. (auth)

Radiation Effects

Refer also to abstracts 38606, 38726, 38747, 38792, 38795, 38824, 38872, 38889, 38890, and 38892.

38453 (ACRH–1000-137) POTENTIATION OF LYMPHOCYTE TRANSFORMATION BY MEMBRANE–MEMBRANE INTERACTION. Yachnin, Stanley; Allen, Lawrence W.; Baron, Joseph M.; Svenson, Robert (Chicago Univ., Ill. Pritzker School of Medicine. Argonne Cancer Research Hospital, Chicago, Ill.). June 1969. Contract AT(11-1)-69. 13p. (CONF-690613–1). Dep. CFSTI. From 4th Leukocyte Culture Conference, Hanover, N. H. Includes Photographs.

It was shown that membrane-membrane interaction brought about by phytohemagglutinin molecules acting as intercellular ligands is an important mechanism for the potentiation of lymphocyte transformation, and that such potentiation occurs even with the cooperation of a mitotically inert particle lacking genetic information such as the red cell or red cell particle. In all probability the increase in DNA synthesis results not from increasing the extent to which any single cell synthesizes DNA, which remains an all or none phenomenon, but rather through an increase in the efficiency with which individual cells are recruited into the transformation process by a mechanism involving cell-cell, or more specifically, membrane-membrane interaction. These observations may have some bearing on the experiments of other investigators which indicate that the lymphocyte membrane undergoes significant modulation of membrane phospholipids as one of the earliest in the process of transformation by phytohemagglutinin. They also fit nicely into the growing body of evidence which indicates that the initiation and perpetuation of the immune response by lymphocytes requires the interaction of two or three varieties of macrophage and/or lymphocytes brought into close and specific contact by antigen and/or antibody molecules acting as ligand. In addition to the possibility of information transfer, such cell-cell interaction may act to provoke the de-repression of the lymphocyte, and thus enable it to synthesize macromolecules and divide. When the ligands and cell receptors are specific, as in immune response, the result is specific, namely antibody synthesis. (auth)

38454 (NSJ-tr-145) HISTOLOGICAL AND HISTOCHEMICAL STUDIES ON THE RADIATION INJURY INDUCED IN THE MULBERRY TREE. [PART] I. EFFECTS OF γ-RAY ON THE DISTRIBUTION OF POLYSACCHARIDE AND PROTEIN WITHIN THE SHOOT APEX. Hazama, Kazuo; Katagiri, Koitsu. Translated from Nippon Sanshigaku Zasshi, 36: No. 6, 477-84(1967). 11p. Dep.

Recently, histological studies were undertaken on the shoot apex irradiated with different kinds of radiation in order to clarify the mechanism of the induction of radiation injury and the chimeric appearance in X_1 plants. It was previously reported in mulberry tree that the outer cytohistological zone (mantle and upper portion of the subapical initials) of the shoot apex was more sensitive than the inner one (inner portion of the subapical initials) when the apical bud was γ-irradiated. The difference of radiation sensitivity observed between two zones was assumed to be due to the diversity of metabolic activity accompanying the organ formation. The results of observation are described on the distribution of polysaccharides and proteins within cytohistological zones of γ-irradiated mulberry shoot apex. Both resting and sprouting buds were irradiated with 5, 10, and 15 kR of γ rays from ^{60}Co at 5 kR/hr. Results are summarized as follows. In the resting buds, without irradiation, the pattern of staining for polysaccharides and proteins was identical in each cytohistological zone, but in the sprouting buds, the granules of polysaccharide were abundant in some cells of the central meristem and the subapical initials. Also, the staining for proteins was found in the top and the flanks of subapical initials. Effects of γ irradiation on the distribution of polysaccharides and proteins within the shoot apex were compared between the resting buds and the sprouting ones. In the resting buds, the number of granules of polysaccharides, being in each cytohistological zone in the course of bud development, was less, and the intensity of staining for proteins was reduced compared with the unirradiated control. While, in the sprouting buds, cells stained for proteins could not be found within subapical initials, but the granules of polysaccharides were detected within the same zone. In the resting buds, with irradiation, the cells that lost the staining for proteins were studded within the shoot apices, but the population of cells that lost the staining for proteins was found in the sprouting buds with irradiation. The distribution of cells, after irradiation, was often found within the subapical initials in which the staining for proteins was observed in the buds without irradiation. Exposure effects on the distribution of polysaccharides and proteins in the shoot apex were not clear when the resting buds were irradiated, but it was found conspicuously when the sprouting buds were irradiated with high exposure. (auth)

38455 KINETICS OF CELL VOLUME CHANGES OF MURINE LYMPHOMA CELLS SUBJECTED TO DIFFERENT AGENTS IN VITRO. Rosenberg, Howard M.; Gregg, Earle C. (Case Western Reserve Univ., Cleveland). Biophys. J., 9: 592-606(Apr. 1969).

Log-phase populations of cells were treated with ionizing radiation and other agents which eventually prevented an increase in cell number. The kinetics of individual cell volume growth, under conditions when the population was constant in number, was inferred from observed changes in median cell volume and shape of the volume spectrum with time. Cultures of murine lymphoma cells (strain L5178-Y) were treated with 100- to 1000-R doses of 250-KV x rays or 200 to 6700 R of ^{60}Co γ rays. During a division delay following irradiation, individual cells increased exponentially in volume with equal rate constants; these rate constants were indistinguishable from that describing the increase in cell number of an unirradiated population. When an originally log phase population of cells was prevented from increasing in number by inhibitors of DNA synthesis, individual cells increased exponentially in volume for about one generation time with the same rate constant as observed after exposure to radiation. Thereafter, only the cells defining the upper half of the volume distribution continued to increase in volume, and they apparently did so with a first-order rate constant proportional to their amount of DNA exceeding that present in one diploid complement of chromosomes in G_1. Cells arrested in mitosis with colchicine increased in volume for ~4 hr after which they remained constant in volume for almost 1 generation time. Eventually these cells again increased in size. Inhibitors of protein and RNA synthesis inhibited the cell volume growth of irradiated cells. Radiation doses up to 6700 R apparently did not alter the kinetics of cell volume growth. (BBB)

38456 IN VITRO FORMATION OF BLOOD LIPID PEROXIDES UNDER THE INFLUENCE OF RADIOISOTOPES. Dousset, N.; Landreaud, B.; Douste-Blazy, L. (Centre Anti-Cancereux, Toulouse). Compt. Rend. Soc. Biol., 162: 1223-6(1968). (In French).

The incubation of blood in the presence of ^{32}P, ^{131}I, and ^{198}Au caused the formation of lipid peroxides. Their rate increased proportionally with the dose of radioactivity; it decreased beginning at a value between 150 and 700 μC, according to the element. The quantity of peroxides increases with the duration of incubation; the maximum was attained in three to 12 hrs, according to the isotope used. The peroxidation of the lipids was more pronounced in the whole blood than in the plasma. (tr-auth)

38457 FORMATION OF MALONALDEHYDE DURING THE γ IRRADIATION OF STARCH FROM CORN. Berger, Gerard; Saint-Lebe, Louis (CEN, Bouches-du Rhone, France). Compt. Rend., Ser. D., 268: 2620-3(May 28, 1969). (In French).

The combined treatment of corn starch with ^{60}Co γ rays and 2-thiobarbituric acid resulted in the production of malonaldehyde. The intensity of the spectra of irradiated starch varied linearly with the radiation dose (0 to 400 krad). A mechanism of malonaldehyde formation is proposed. (tr-auth)

38458 SYNTHESIS OF DEOXYRIBONUCLEIC ACID AFTER ULTRAVIOLET IRRADIATION OF SENSITIVE AND RESISTANT HAEMOPHILUS INFLUENZAE. Modak, Sohan P.; Setlow, Jane K. (Oak Ridge National Lab., Tenn.). J. Bacteriol., 98: 1195-8(June 1969).

Synthesis of deoxyribonucleic acid (DNA) has been measured as a function of ultraviolet (uv) radiation dose in wild-type and seven uv-sensitive strains of Haemophilus influenzae. At the uv doses used, all strains were able to resume DNA synthesis, even those which are unable to excise pyrimidine dimers from their DNA. These excisionless strains showed longer uv-induced de-

lays in DNA synthesis than all but one of the other strains. The longest delay was shown by DB117, a strain which can excise dimers but which is recombination deficient and unable to rejoin x-ray-induced single-strand breaks. All strains showed a progressive decrease in sensitivity as they approached the stationary phase. (auth)

38459 QUANTITATIVE CHANGES OF ACID PHOSPHATASE IN THE HYPOTHALAMUS, PITUITARY, ADRENALS, AND THYROID OF MICE (MUS MUSCULUS L.) EXPOSED TO LARGE, SINGLE DOSES OF UV OR X-RAYS, TAKING INTO ACCOUNT THE CIRCADIAN RHYTHM. Surowiak, J. (Jagiellonian Univ., Krakow). Folia Biol. (Krakow), 17: 105-40(1969).

Acid phosphatase in the hypothalamus, hypophysis, adrenals, and thyroid of mice exhibits distinct, rhythmic quantitative changes during the day. Apparent differences between sexes were found in the course of the circadian rhythm curves of the phosphatase content in the studied organs. The hypothalamus-pituitary-adrenal system showed the same diurnal rhythm of the enzyme in normal conditions. Ultraviolet and ionizing (x rays) radiations produced statistically significant alterations in the circadian rhythm of acid phosphatase both in males and females. The trend of return to normal values of the enzyme within 24 hr of exposure was observed. X rays caused more pronounced quantitative changes of the enzyme during the first 12 to 18 hr after irradiation of animals. In males the phosphatase content in the studied glands and hypothalamus was increased after irradiation with uv and x rays. The reverse reaction—decrease of the enzyme following irradiation—was found in females. It was concluded that quantitative alterations of acid phosphatase in its circadian rhythm provide a very sensitive test of changes occurring in various organs and endocrine glands in response to a non-specific stress. Quantitative measurements of the enzyme were carried out by a cytophotometric method using histochemical reactions. (auth)

38460 THE ROLE OF MEDIATORS IN THE MECHANISM OF DISTURBING THE TRANSMISSION OF EXCITATION IN SYMPATHETIC GANGLIA OF IRRADIATED ORGANISMS. Mtskhvetadze, A. V.; Titova, R. I. (Central Scientific-Research Roentgenology-Radiological Inst., Moscow. Leningrad Medical Inst.). Dokl. Akad. Nauk SSSR, 185: 479-81(Mar. 11, 1969). (In Russian).

The upper cervical sympathetic ganglia of cats were investigated after three types of irradiation: local irradiation with a ^{90}Sr, β applicator at doses of 800 and 2500 rads, whole-body irradiation with an 800 rad, x-ray dose with shielding of the ganglion, and whole-body irradiation with an 800 rad, x-ray dose without any shielding of the ganglion. It was found that the total and free acetylcholine content in the irradiated ganglia was increased as compared with the control ganglia, especially after whole-body irradiation. On the other hand, the cholinesterase activity in the irradiated ganglia was decreased in the majority of cases. The bioelectrical activity of the ganglia was increased by a local dose of 800 rads, but was suppressed by 25% on increasing the local dose to 2500 rads. (TTT)

38461 LACK OF IN VITRO PHOTOREACTIVATION OF DNA EXTRACTED FROM ULTRAVIOLET IRRADIATED B. SUBTILIS SPORES. Tanooka, Hiroshi (National Cancer Center Research Inst., Tokyo). Photochem. Photobiol., 9: 95-7(Jan. 1969).

Transforming DNA extracted from Bacillus subtilis spores or spore-spheroplasts following exposure to uv radiation was not subject to photoreactivation; while it could be photoreactivated when uv irradiation was performed after rupture of spheroplasts and when yeast enzyme was added during the subsequent illumination. The results suggest that the photoproducts in the spore-spheroplasts were not substrates from the yeast enzyme, while those ruptured spheroplasts were. It was concluded that this indicated different yields of normal cyclobutane-type products in the two systems. (C.H.)

38462 X IRRADIATION AND AGING AS REFLECTED IN THE ACCUMULATION AND INSOLUBILIZATION OF COLLAGEN. Tsurufuji, S.; Obuchi, K. (Tokyo Univ.). Exp. Gerontol., 3: 309-15(Dec. 1968).

Since irradiation changes may resemble aging effects, attempts were made to detect age-related changes in collagen of irradiated animals. Male mice received 300 R of whole-body x irradiation four times, at 6, 43, 45, and 48 weeks of age. Skin collagen was divided into two fractions, neutral salt soluble and insoluble collagens, by prolonged extraction of the minced skin with 1M NaCl. The ratio of insoluble collagen to neutral salt soluble collagen was increased significantly by a total of 1200 R of whole-body irradiation at three and 21 weeks after the last irradiation. However, a single 300 R dose did not cause any significant increase at eight weeks after the irradiation. In addition to tissue concentrations, total contents of collagen in entire lung, heart, and kidney constantly increased with aging. X irradiation caused no significant elevation in the concentration or total content of collagen in any of the three organs or the skin throughout the experimental period of 14 to 65 weeks of age. Shortening of life span by x irradiation did not correlate with the accumulation of collagen in tissues. (BBB)

38463 CYTOSINE DERIVED HETEROADDUCT FORMATION IN ULTRAVIOLET IRRADIATED DNA. Varghese, A. J.; Patrick, M. H. (Southwest Center for Advanced Studies, Dallas). Nature (London), 223: 299-300(July 19, 1969).

Pyrimidine photoproducts other than cyclobutyl dimers have been isolated from irradiated pyrimidines, as well as from DNA. Two products, in addition to the cis-syn cyclobutyl thymine homodimer, were isolated from irradiated frozen solutions of thymine; one of these was found to be a thymine-thymine adduct. A uracil-thymine adduct was also found after irradiation of a mixture of uracil and thymine in frozen solution, and was also isolated from acid hydrolysates of uv-irradiated calf thymus DNA. These adducts showed an absorption maximum at 315 nm and may have been responsible for the absorbence increase at this wavelength observed in irradiated solutions of DNA. From the studies described it is shown that the U-T adduct is derived from an initially formed photoproduct involving thymine and cytosine, but no evidence was found for formation of T-T adducts in DNA. It was found that the U-T adduct could be isolated from acid hydrolysates of an irradiated mixture of cytidine and thymidine, and from the corresponding nucleotides. Similar studies were also conducted with E. coli grown in a medium containing thymidine, uracil, arginine, l-tryptophan and vitamin-free casamino acids, and with DNA isolated from E. coli, except that cytosine was substituted for uracil in the culture medium. Results were consistent with the U-T adduct being derived by deamination of an initially formed cytosine-thymine photoproduct in DNA. Evidence in favor of this conclusion was obtained from studies of triplet sensitised irradiation of DNA in vitro; no U-T adduct formation occurred in this case. The results extend the range of known UV-induced pyrimidine changes in DNA. (UK)

38464 EARLY EFFECTS OF ULTRAVIOLET LIGHT ON DNA SYNTHESIS IN HUMAN SKIN IN VIVO. Epstein, William L.; Fukuyama, Kimie; Epstein, John H. (Univ. of California, San Francisco). Arch. Dermatol., 100: 84-9(July 1969).

The early effects of ultraviolet light (UV) irradiation on deoxyribonucleic acid (DNA) synthesis in human skin were studied in vivo. Volunteers exposed to three minimal erythema doses (MED) ($8.2-40.8 \times 10^6$ ergs/sq cm) were injected intradermally with tritiated thymidine ($TdR-^3H$), immediately, 15 minutes, 3, 5, and 24 hr afterward, and biopsies processed for light microscopy autoradiography. Comparison of the results with findings in unirradiated human skin indicated: a depression in the number of germinative basal cells synthesizing DNA prior to division at 3 and 5 hr after UV, as seen in other systems; a population of sparsely labeled cells not only in the basal layer but also in the malpighian and granular layers and not seen in unirradiated skin or after several other types of acute injury. This aberrant type of $TdR-^3H$ incorporation was seen in other systems and is thought to represent dark reactivation repair of irradiated DNA as occurs in microorganisms. (auth)

38465 EFFECTS OF IONIZING RADIATION ON ERYTHROCYTES. PART II. EXPERIMENTAL RESULTS. Gerhardt, Paul (Univ., Tuebingen, Ger.). Strahlentherapie, 137: 478-92 (Apr. 1969). (In German).

The Heinz inclusion bodies are counted in erythrocytes and their number is used as a sensitivity test for radiation exposure. In normal persons the average number of red cells showing more than four inclusion bodies is 11%, whereas personnel professionally exposed to ionizing radiation show a mean value of 23%. A similar increase in inclusion bodies in erythrocytes is found after therapeutic radiation of patients with various tumors. In addition, the effect of ionizing radiation is studied on erythrocytes with respect to various enzymes, volume distribution, and osmotic resistance. (H.B.G.)

38466 CHANGE IN PHOSPHATASE AND SUCCINATE DEHYDROGENASE ACTIVITIES IN THE MUCOUS MEMBRANE OF THE SMALL INTESTINE DURING RADIATION DAMAGE IN EARLY ONTOGENESIS. Brodskii, R. A.; Nikolaeva, N. N. (Inst. of Medical Radiology, Moscow). Med. Radiol., 14: No. 5, 81-2 (May 1969). (In Russian).

White Wistar rats, 3, 4, 5, 6, 7, 8, and 9 weeks old were given a whole-body ^{60}Co dose of 500 R. The rats were killed one week after irradiation at about the same period of development of ra-

diation sickness. Control rats of the same age were killed at the same time. The small intestine was separated into anterior, middle and posterior sections. The material was fixed in 80% alcohol, and paraffin sections 7 microns thick were treated in order to determine the alkaline phosphatase and succinate dehydrogenase activities. Histochemical changes could be clearly noted, even though there were no significant changes in the structure of the mucous membrane. The most noticeable decrease in the fall of alkaline phosphatase activity took place in the anterior and middle sections of the small intestine from rats irradiated at 3 weeks of age. The activity of succinate dehydrogenase in the cell decreased even faster than the alkaline phosphatase activity, because of the presence of sulfhydryl groups in succinate dehydrogenase that make this enzyme more radiosensitive. (TTT)

38467 EFFECT OF OXYGEN ON ULTRAVIOLET INACTIVATION OF MYOSIN. Kalabukhova, T. N.; Kondakova, N. V.; Eidus, Kh. L. (Inst. of Biological Physics, Pushchino-on-Oka, USSR). Biophysics (USSR) (Engl. Transl.), 13: 383-7(1968). Translated from Biofizika, 13: 326-8(1968).

On exposure of myosin solutions to uv irradiation no difference was found in the degree of inactivation following anaerobic or aerobic irradiation with determination of the activity in the absence of oxygen. On exposure of anaerobically irradiated protein to air there was additional inactivation (oxygen after-effect), the value of which was 25 to 30% of the activity of the irradiated protein at all doses of radiation. The fact that the value of the oxygen after-effect is independent of the wavelength indicates that this reaction comes about apparently through the energy absorbed by the aromatic amino acid residues. The oxygen after-effect is caused by processes that do not proceed on irradiation in the presence of air, which indicates the difference in the reactions occurring on uv irradiation of myosin in vacuo and air. (auth)

38468 EFFECT OF ULTRAVIOLET LIGHT ON THE EPIDERMIS. III. HISTOCHEMISTRY OF CELL RESPIRATION AND PHOSPHORYLATION. Szabo, Eva; Horkay, Iren (Univ. Medical School, Debrecen, Hungary). Acta Morphol. Acad. Sci. Hung., 16: 305-9(1968).

Histochemical changes induced in the epidermis of man following exposure to uv light were studied. Following the administration of a single large dose of uv light, succinic dehydrogenase activity increased during the first hours in the basal-cell layer and the stratum granulosum. It disappeared from the latter, but increased further in the prickle cell and the basal cell layers at the appearance of parakeratosis. Activity was vigorous in the entire epidermis, and especially so in the stratum granulosum, at the desquamation of parakeratosis. Acid phosphatase activity increased during the first hours in the stratum granulosum and the stratum corneum, and became very intensive in the entire epidermis at the development of parakeratosis, but decreased during desquamation. Non-specific esterase activity was intensive in the parakeratotic nuclei. Repeated administration of single erythema doses of uv light moderately increased succinic dehydrogenase activity in the entire epidermis, especially in the stratum granulosum. Acid phosphatase activity was pronounced in the hyperkeratotic zone and in the stratum granulosum. Absorption of uv rays by the stratum granulosum, promoted cellular metabolism, induced quicker and imperfect nuclear degeneration, and induced the development of parakeratosis. Small doses of uv light induced hyperkeratosis because the amount of imparted energy was not sufficient to impair cellular activity. (auth)

38469 ENZYMATIC REPAIR OF DNA. 1. PURIFICATION OF TWO ENZYMES INVOLVED IN THE EXCISION OF THYMINE DIMERS FROM ULTRAVIOLET-IRRADIATED DNA. Kaplan, Joan C.; Kushner, Sidney R.; Grossman, Lawrence (Brandeis Univ., Waltham, Mass.). Proc. Nat. Acad. Sci. U. S., 63: 144-51(May 1969).

Two nucleases that catalyze the excision of photoproducts from uv-irradiated DNA were extensively purified from Micrococcus luteus (M. lysodeikticus). The first enzyme, an endonuclease, was purified 5000-fold and is free of conflicting nuclease activities. It introduced single-strand breaks into irradiated DNA but did not act on native or single-stranded DNA. The purified enzyme was activated but not dependent on Mg^{2+} and had an approximate molecular weight of 15,000. Photoproduct excision was absolutely dependent on the second enzyme, a magnesium requiring exonuclease. This enzyme, that was purified 1000-fold, was devoid of conflicting nucleases. It hydrolyzed irradiated and unirradiated denatured DNA at the same rate, but had no activity on RNA. It only acted on double-stranded DNA that was both irradiated and pretreated with the endonuclease. The combined action of the endo- and exonuclease resulted in the quantity removal of photoproduct regions from uv-irradiated DNA. Approximately five nucleotides were released for every single-strand incision. (auth)

38470 CHANGES IN THE PROTEIN AND AMINO-ACID COMPOSITION OF RABBIT SERUM WITH EXTERNAL IRRADIATION. Kurtser, B. M.; Dovganskii, A. P. Zdravookhranenie (Kishinev), 1: 23-6(1967). (In Russian).

Studies were made in 28 male rabbits 30 min and 1, 3, and 7 hr after exposure to 500 R of x radiation. The protein and free amino-acid composition, morphological changes, hemoglobin concentration, and hematocrit reading of the peripheral blood were studied. After x irradiation the animals showed leukopenia and erythropenia and a decrease in the hematocrit reading. As early as one day after x irradiation, observations were made of dysproteinemia, as manifested by a fall in the concentration of albumins and gamma globulins and a rise in the concentration of α- and β-globulins. At all the intervals of the study the serum showed various changes in the concentration of free amino acids. The exceptions were phenylalanine, which decreased uniformly, lysine (which rose), and tryptophane, whose concentration rose from the 3rd day. (auth)

38471 D_2O AS INHIBITOR IN THE AUXIN-INDUCED SYNTHESIS OF RNA. Dahlheim, Helga; Huebner, G. (Institut fuer Stabile Isotope, Leipzig). Naturwissenschaften, 56: 89(Feb. 1969). (In German).

The auxin-induced synthesis of RNA was studied in the presence of D_2O sections from Pisum sativum seedlings. The sections were incubated in H_2O, H_2O + indolyl-3-acetic acid (IES), D_2O, and D_2O + IES with $Na_2H^{32}PO_4$. After 18 hrs of incubation, the introduction of ^{32}P in the RNA of the sections was determined. The results show that the IES accelerated the ^{32}P incorporation into the RNA. In heavy water, auxin did not stimulate the ^{32}P incorporation into the RNA. The results are tabulated. (J.S.R.)

38472 GAMMA RADIATION EFFECTS ON THE PECTIC SUBSTANCES IN CITRUS FRUITS. Rouse, A. H.; Dennison, R. A. (Univ. of Florida, Lake Alfred). J. Food Sci., 33: 258-61(May-June1968).

The quantitative changes of the pectic fractions and the pectinesterase activity in the component parts of γ-irradiated Valencia oranges and Duncan grapefruit were studied, and the effects of irradiation upon the characteristics of the pectins (such as jelly grade, methoxyl content, and jelly units) extracted from the fruit components were evaluated. Exposure of citrus fruits to γ radiation at doses of 150 and 300 KR increased the water- and oxalate-soluble pectins and decreased the protopectin in component parts of Valencia oranges and Duncan grapefruit. The quantities of water-soluble pectin and protopectin in the peel and membrane were most affected by irradiation. Degradation of the pectins as measured by jelly grade increased in all components of the irradiated fruits. The greatest decrease in jelly grade occurred in the March samples when the Brix/acid ratio was least. Methoxyl content of the pectins from the peel of oranges and grapefruit decreased, but methoxyl decreased only slightly in pectins from the membrane of irradiated fruits. Pectinesterase activity in the peel of both oranges and grapefruit decreased with increased dosages, while the activity in the membrane of both fruits increased. (BBB)

38473 SATURATION OF DARK REPAIR SYNTHESIS: ACCUMULATION OF STRAND BREAKS. Achey, Phillip; Billen, Daniel (Univ. of Florida, Gainesville). Contract AT(40-1)-2695. Biophys. J., 9: 647-53(May 1969).

Some strains of Escherichia coli are able to repair damage to DNA by a dark repair system after uv light exposure. As the uv dose is increased, the cell is unable to survive the lethal damage induced by the uv radiation and colony-forming ability is lost. E. coli B/r hcr^+ cells were used to investigate the consequence of saturation of the repair enzyme system. To distinguish DNA synthesized postirradiation from parental DNA, density labeling and isopycnic analysis were employed. Density labeling was achieved with ^{15}N, ^{13}C, and ^{2}H. This produced DNA which was heavy in both strands. Light medium containing ^{12}C, ^{14}N, and ^{1}H was used for postirradiation incubation. For postirradiation times longer than 40 min there was no additional incorporation of ^{3}H-label into the parental strands; i.e., repair synthesis was completed by 40 min. Analysis of DNA contained in cells at the time of uv exposure and subsequently subjected to repair showed decrease in size with increasing dose. This suggests that excision, which produces gaps, occurs in excess of the repair synthesis and rejoining steps at uv doses greater than 100 erg/mm^2. Repair synthesis is not proportional to dose above 200 erg/mm^2. It was concluded that the extent of repair is limited by saturation of the repair synthesis step. (BBB)

38474 ESTERASE ACTIVITY, PROTEIN CONTENT, AND WEIGHT OF THE SPLEEN OF WHOLE-BODY X-IRRADIATED RATS, WITH CONSIDERATION OF FUNCTIONAL AND MORPHOLOGICAL ASPECTS. Valet, G.; Gross, H. J.; Ruhenstroth-Bauer,

G. (Max-Planck-Institut fuer Biochemie, Munich). Virchows Arch., B, 2: 326-44(1969). (In German).

Esterase activity (between pH 5.0 and 8.5) and protein content of splenic extracts, as well as the spleen weight, of 500-R whole-body x-irradiated rats were studied from the first to 18th day after irradiation. Esterase activity/mg protein was significantly increased when tested at pH 5.0 and 6.0 from the first to ninth day and for pH 6.5 to 8.5 from the second to ninth day. It was significantly decreased at pH 6.0 to 6.5 on the 18th day. The protein concentration of splenic extracts was significantly increased on the first day and decreased from the sixth to 15th day. The weight of the spleen was significantly decreased, as compared with controls, from the first to ninth day and increased on the 18th day after irradiation. Morphologic changes after irradiation were studied in splenic cells. There were decreases in cell size and in content and concentration of cell protein. The cell protein concentration was low the longest time and required the most time for restoration. The content of cell esterase was decreased for all pH values from the first to ninth day, with the exception of an increase for pH 5.0 and 6.0 on the first and second day after irradiation. The concentration of cell esterase was increased for all pH values from the first to third day after irradiation, a result of the loss of nonesterase active protein from the cells. After the third day it was decreased, up to the ninth day. The damaged splenic cells contained protein and esterase. The surviving cells of the spleen were richer in protein and showed more esterase activity than injured cells. Biochemical results on single cells of irradiated rat spleen parallel histological findings. (BBB)

38475 ELECTRON MICROSCOPIC AND HISTOCHEMICAL STUDIES OF SMALL INTESTINE FOLLOWING ^{60}Co γ IRRADIATION. Khamidov, D. Kh.; Mirakhmedov, A. K.; Saidov, T. M. (Inst. of Botany, Alma-Ata, USSR). Dokl. Akad. Nauk Uzb. SSR, No. 2, 51-3(1969). (In Russian).

Effects of lethal and sublethal γ ray doses on certain chemical components and small intestine cell ultrastructure were studied using white male rats weighing 150 to 220 g irradiated with 18 to 20 R/sec with 800 R and decapitated 2, 4, 6, and 24 hr following the exposure and with 400 R dose decapitated 30 days after exposure. It was found that a considerable swelling of mitochondria and a large number of mitochondrian vacuoles appeared even after 60 min following the exposure to 800 R. Ultrastructural disturbances; change of nuclear shape; breakdown of the mitochondria up to complete destruction were observed after exposure to the 400 R dose. However, the number of destroyed mitochondria was smaller than with 800 R doses. The activity of succinic dehydrogenase and cytochromoxidase was perceptibly reduced. A large number of granular cells not connected to the membrane of endoplasmic reticulum was observed with both 400 and 800 R doses. (R.V.J.)

38476 ANALYSIS OF PHOTOENZYMATIC REPAIR OF UV LESIONS IN DNA BY SINGLE LIGHT FLASHES. III. COMPARISON OF THE REPAIR EFFECTS AT VARIOUS TEMPERATURES BETWEEN +37° AND -196°. Harm, Helga (Southwest Center for Advanced Studies, Dallas). Mutat. Res., 7: 261-71 (May-June 1969).

Transforming DNA of uv-irradiated Haemophilus influenzae can be repaired in vitro in the presence of yeast photoreactivating enzyme (PRE) by an intense light flash of about 1 msec duration. Such a flash repairs a fraction >0.9 of enzyme-complexed photorepairable lesions at all temperatures between +37° and −40°, but only a fraction of about 0.25 or 0.1 at −78° or −196°, respectively. A similar decline below −40° is observed for photoenzymatic repair (PR) of E. coli B_{s-1} cells and for PR of transforming DNA by continuous illumination with white light. The decreased effects at low temperatures result neither from damage to the reaction mixture by freezing or by the illumination itself, nor do they result from dissociation of the PRE−substrate complexes in the dark. The drastic reduction in the extent of PR is observed already below −2° if the photolytic reaction is limited by using a less intense light flash. These results are best explained by assuming that the relative repair efficiency of incident photons drops substantially below −2°, but this is not noticed with a very intense flash, where the number of incident photons is excessive. It remains open whether the decreasing repair efficiency with decreasing temperature reflects reduced absorbance or a reduced quantum yield of the absorbed photons. Increased PR effects at −78° and −196° can be obtained by sequential flashes or by increased periods of illumination with white light, but the kinetics indicate the presence of two or more fractions of PRE−substrate complexes, differing in the probabilities of repair. At low temperature as well as at room temperature flashes photolyse a majority of the complexes more efficiently than equivalent doses of continuous illumination, suggesting an enhancement of PR by absorption of two or more photons within a limited time interval. (auth)

38477 SERUM ORNITHINE CARBAMOYL TRANSFERASE ACTIVITY (S-OCT) AFTER IRRADIATION OF MALIGNANT TUMORS AND AFTER ADMINISTRATION OF ACTH. Brohult, Johan (Sodersjukhuset, Stockholm). Acta Med. Scand., 185: 363-8(Apr. 1969).

Operation trauma was followed after 4 to 7 days by a rise in serum-ornithine carbamoyl transferase (S-OCT) that was assumed to be induced, at least in part, by the postoperative breakdown of protein. This rise in S-OCT, however, was significantly correlated to the postoperative increase in the excretion of nitrogen and 17-hydroxycorticosteroids. The present study was undertaken to elucidate the importance of protein catabolism and stimulation of the adrenal cortex for the rise in S-OCT 4 to 7 days after irradiation. Twenty women who received 20-hr Ra implantation therapy for cancer of the uterine cervix displayed a significant rise of S-OCT 4 to 6 days later. This rise could not be explained by increased adrenocortical stimulation elicited by the trauma because such stimulation (90 I.U. ACTH) in 10 healthy subjects resulted in a significant drop in S-OCT. A study of the nitrogen balance in six other subjects showed that adrenocortical stimulation with 90 I.U. ACTH did not increase the breakdown of protein. These observations indicated the increases in S-OCT observed a few days after conditions causing an elevated breakdown of protein may be due to a release of an additional amount of OCT that is supposedly formed in the human liver during the maximal breakdown of protein. (BBB)

38478 ENERGY DEPENDENT NUCLEOLYTIC PROCESSES ARE RESPONSIBLE FOR THE PRODUCTION OF MANY POST-IRRADIATION BREAKS IN L CELL DNA. Dalrymple, Glenn V.; Sanders, J. L.; Moss, A. J. Jr.; Baker, Max L.; Wilkinson, K. P. (Univ. of Arkansas Medical Center, Little Rock. Veterans Administration Hospital, Little Rock). Biochem. Biophys. Res. Commun., 36: 284-8(July 23, 1969).

L cells x-irradiated while in growth medium or in a balanced salts solution showed a rapid appearance of DNA breaks characterized by 5′ phosphoryl termini. Following irradiation, the number of breaks quickly reached a maximum, after which they were rapidly repaired. Dinitrophenol, an inhibitor of aerobic oxidative phosphorylation, prevented the DNA breaks from appearing. (auth)

38479 EFFECT OF X-RAY INDUCED SYNCHRONY ON TWO-DOSE CELL SURVIVAL EXPERIMENTS. Young, Judith M.; Fowler, John F. (Hammersmith Hospital, London). Cell Tissue Kinet., 2: 95-110(Apr. 1969).

Calculations were made based on experimental data of the variation in radiosensitivity and in cell cycle delay with age in Chinese hamster cells. The computed syntheses included: single-dose survival curves; split-dose recovery curves, the pattern of survival; and two-dose survival curves, the shape of the second survival curve. It is clear that, after an initial dose, changes occur in the subsequent dose-response curve which depend upon size of dose and time after irradiation. Following rapid and apparently complete repair of sublethal injury, these changes can be attributed to progression of a partially synchronized population through phases of varying radiosensitivity. These changes may be small in some systems, but important in others. The concept of equal dose-increments after each of several dose fractions is an over-simplification and must be used with care. (auth)

38480 SINGLE STRAND INTERRUPTIONS IN DNA AND THE EFFECTS OF CAFFEINE IN CHINESE HAMSTER CELLS IRRADIATED WITH ULTRAVIOLET LIGHT. Cleaver, J. E.; Thomas, G. H. (Univ. of California Medical Center, San Francisco). Biochem. Biophys. Res. Commun., 36: 203-8(July 23, 1969).

DNA synthesized in bacteria after irradiation with ultraviolet (uv) light contained numerous interruptions in the polynucleotide chains. These interruptions may be due to uv photoproducts on the opposite strand and are subsequently closed by a process distinct from semiconservative replication of DNA. These bacterial experiments were repeated with Chinese hamster cells to determine whether a similar process exists in mammalian cells. (auth)

38481 EFFECTS OF GAMMA IRRADIATION ON THE VITAMIN CONTENT OF DIETS FOR LABORATORY ANIMALS. Coates, Marie E.; Ford, J. E.; Gregory, Margaret E.; Thompson, S. Y. (National Inst. for Research in Dairying, Reading, Eng.). Lab. Anim., 3: 39-49(Apr. 1969).

The effects of ^{60}Co γ irradiation on the vitamin content of diets intended for germ-free chickens and for specific pathogen-free guinea pigs and cats were examined. Practical-type animal diets and a chick diet of purified ingredients were assayed for vitamin content before and after irradiation at doses ranging from 2 to 5 Mrad. Irradiation of guinea pig and chick diets resulted in small losses of vitamin A (6 and 12% respectively). Losses of vitamin E

were larger (24 and 65%) but were much less when the diets were vacuum-packed before irradiation. Vitamins were less stable in the purified chick diets, the most susceptible being vitamins A, E, B_6, and thiamin. Vitamin destruction was greatly increased when antioxidants were incorporated into this diet, and when its moisture content was high. The antioxidants were 0.005% ascorbic acid or 0.0125% 1,2-dihydro-6-ethoxy-2,2,4-trimethylquinoline (Santoquin). In the moist diet also there was almost complete destruction of folic acid and some loss of nicotinic acid. Vitamin A and β-carotene were almost completely destroyed in the cat diet, and there was also some loss of thiamin and folic acid. (BBB)

38482 EFFECT OF IONIZING RADIATION ON TRYPTOPHAN OXYGENASE OF RAT LIVER. Benes, Jiri; Zicha, Blahoslav (Charles Univ., Prague). Strahlentherapie, 137: 612-19(May 1969).

Ionizing radiation with an exposure dose of 1400 R does not change in early time intervals after the irradiation the tryptophan oxygenase levels in rat liver. The substrate induction of tryptophan oxygenase is rather stimulated by x-rays given 24 hours before the administration of the inducer. The hormonal induction of the enzyme is inhibited after initial stimulation. The exposure dose of 1400 R given to rats at zero time prior to the partial hepatectomy inhibits the increased levels of tryptophan oxygenase observed 12 hours after the tissue resection. The same result was determined when actinomycin D was administered to rats one hour after the partial hepatectomy. The diminished synthesis of tryptophan oxygenase in irradiated regenerating rat liver tissue, as well as the decrease of hormonal induction after the irradiation can be explained by the inhibition of the specific messenger RNA's synthesis. (auth)

38483 STUDIES OF TRYPTOPHAN METABOLISM IN ISOLATED PERFUSED ORGANS UNDER NORMAL CONDITIONS AND AFTER IRRADIATION. PART I. TRYPTOPHAN CATABOLISM IN THE ISOLATED PERFUSED RAT LIVER. Gerber, Georg B.; Altman, Kurt I.; Gerber, Gisela; Deknudt, Ghislain (EURATOM, Mol, Belg. Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Strahlentherapie, 137: 620-5(May 1969). (In German).

Tryptophan metabolism by the isolated perfused liver from non-irradiated and x irradiated rats was investigated at normal substrate levels and under loading conditions. X irradiated liver showed a decrease in tryptophan catabolism, a delay in induction or activation of tryptophan pyrrolase and an increase in excretion of metabolites via the bile. From the data several rates of reaction of tryptophan metabolism were calculated. (auth)

38484 EFFECT OF NON-TOXIC CONCENTRATIONS OF ACRIFLAVINE ON UNSCHEDULED DNA-SYNTHESIS AND SURVIVAL OF SYNCHRONIZED HeLa CELLS EXPOSED TO ULTRAVIOLET LIGHT. Evans, Richard G.; Djordjevic, Bozidar (Sloan-Kettering Inst. for Cancer Research, New York). Int. J. Radiat. Biol., 15: 239-44(1969).

Non-toxic concentrations (3×10^{-6} M) of acriflavine depress the unscheduled DNA-synthesis in G1 HeLa cells at low ultraviolet doses (<50 ergs/mm^2), but not at higher doses. Moreover, these drug concentrations have little effect on survival at uv doses where the depression of unscheduled DNA-synthesis is greatest. (auth)

38485 ULTRAVIOLET INACTIVATION AND PHOTOPRODUCTS OF TRANSFORMING DNA IRRADIATED AT LOW TEMPERATURES. Rahn, R. O.; Setlow, Jane K.; Hosszu, J. L. (Oak Ridge National Lab., Tenn.). Biophys. J., 9: 510-17(Apr. 1969).

Solutions of Haemophilus influenzae transforming DNA were irradiated at temperatures ranging from 25°C to −196°C. Ultraviolet sources providing radiation at 270 and 254 nm were used. Temperature dependence of the formation of thymine-containing dimers was closely correlated with inactivation of transforming activity. In general, both dimerization and inactivation decreased with decreasing temperature. The fraction of nonphotoreactivable damage increased with increasing dose at low temperatures. The nonphotoreactivable spore-type photoproduct was formed at low temperatures with a maximum at −100°C, a temperature at which the nonphotoreactivable biological inactivation was also a maximum. Intrastrand cross-linking, like dimer formation, decreased with decreasing irradiation temperature. The spore-type photoproduct was estimated to be less than 20% as lethal as a thymine-containing dimer. The relative biological effectiveness of different photoproducts may reflect differences in the ability of the organism to repair them. (BBB)

38486 STUDIES OF THE EFFECTS OF IONIZING RADIATION ON ERYTHROCYTES. PART III. DISCUSSION AND SUMMARY. Gerhardt, Paul (Univ., Tuebingen, Ger.). Strahlentherapie, 137: 564-71(May 1969). (In German).

After in vitro and in vivo irradiation of erythrocytes, the resistance of hemoglobin against acetylphenyl-hydrazine is lowered. In the Heinz corpuscle-formation test, one can observe significantly more corpuscles than in non-irradiated erythrocytes. This enhanced denaturation possibility of the hemoglobin can also be observed in professionally exposed persons, in animals and after radiation therapy. The formation of corpuscles is mainly observed in erythrocytes, where the glycolytic enzymatic activity and osmotic resistance is lowered. One can deduce that it concerns old erythrocytes, whose protection capabilities to ionizing radiations is reduced. (auth)

38487 INTERMEDIATE METABOLIC PRODUCTS OF UREA SYNTHESIS FOLLOWING LOCALIZED LIVER IRRADIATION. Staehler, Fritz (Univ., Hamburg). Strahlentherapie, 137: 546-53(May 1969). (In German).

The effects of localized liver irradiation on some metabolic products of the urea-cycle (ammonia, urea, ornithine and arginine) were studied in the rat liver and plasma. The dose was 1000 or 5000 Rad and the observation period lasted until the fourth day. A pronounced elevation of the amount of free amino acids was observed in the liver after 24 hours. The concentration of ammonia and urea increased while the ratio remained unaffected. No significant variations were observed in the plasma. An overflow of the organism with ammonia and urea as end-products of the nitrogen metabolism was not noticed. (auth)

38488 CATALASE ACTIVITY IN HOMOGENATES OF KIDNEY, SPLEEN, AND TESTES AFTER WHOLE-BODY IRRADIATION OF MALE MICE. Vodicka, Ivan (Militaermedizinische Forschungs- und Fortbildungsinstitut, Hradec Kralove, Czech.). Strahlentherapie, 137: 730-3(June 1969). (In German).

The catalase activity was studied in the testicles, the spleen and the kidneys of white male mice, after whole-body irradiation of 700 r and compared with control animals. The observation was made at 3, 24, 27, and 168 hours after irradiation. In the normal mice marked differences are observed in the organs. The increased activity of the catalase parallels the radioresistance of the organs in the order cited. After the irradiation a significant decrease of the catalase activity is observed within 72 hours. The modification of this activity in the testicles and the spleen is not significant. (auth)

38489 METABOLIC STUDIES WITH NICOTINAMIDE COENZYME FOLLOWING WHOLE-BODY IRRADIATION. PART I. CATABOLISM OF NAD AND EXCRETION OF ITS METABOLITES. Gerber, Georg B.; Deroo, Jules (EURATOM, Mol, Belg. Centre d'Etude de l'Energie Nucleiare, Mol, Belg.). Strahlentherapie, 137: 724-9(June 1969). (In German).

Labeled nicotinic acid was injected in mice and rats and the animals were whole-body irradiated 24 hours later. Excretion of the labeled metabolites and data on radioactivity in tissues showed that x-irradiation, but also to a certain extent starvation per se, accelerates catabolism of NAD and results in an enhanced excretion of labeled metabolites. (auth)

38490 CHANGE IN THE BASE COMPOSITION OF MESSENGER RNA OF ESCHERICHIA COLI BY ULTRAVIOLET IRRADIATION AND ITS RECOVERY. Yonei, Shuji; Tokunaga, Fumio; Nozu, Keiichi (Osaka Univ.). Photochem. Photobiol., 9: 537-48(June 1969).

The base composition of messenger RNA in Escherichia coli B/r and B_{s-1} irradiated with ultraviolet light was examined. The synthesis of rapidly labeled RNA did not stop in ultraviolet irradiated bacteria. The rapidly labeled RNA in irradiated cells showed a change in base composition corresponding to the formation of pyrimidine dimers in DNA molecules. The mole per cent of adenine component was increased with ultraviolet dose. The ratio of purine/pyrimidine became larger and the GC content smaller. The base composition of the rapidly labeled RNA in irradiated bacteria reversed to that in unirradiated cells, when the irradiated cells were reactivated by experimental procedures for photoreactivation or dark reactivation. The reversion in the base composition corresponded well to the decrease in the amount of thymine dimers in DNA molecules. The mechanism of the change in the base composition of rapidly labeled RNA caused by ultraviolet irradiation is discussed. (auth)

38491 ENDOGENOUS NON-PROTEIN SULPHYDRYL AND CELLULAR RADIOSENSITIVITY. Harris, J. R. (Univ. of California Medical Center, San Francisco); Painter, R. B.; Hahn, G. M. Int. J. Radiat. Biol., 15: 289-92(1969).

The relationship between the content of endogenous non-protein SH and age-dependent radiosensitivity was examined by measuring non-protein SH during portions of the cell cycle of mammalian cells and by testing the survival of cells irradiated after chemical oxidation of their endogenous non-protein SH. Although fluctua-

tions in the content of non-protein SH occurred during the cell cycle, it was thought that they did not cause the differential radiosensitivity of cells in G_1, G_2, and S. This conclusion was based on the lack of correlation between non-protein SH content and radiosensitivity. (H.L.W.)

Immunology

Refer also to abstracts 38532, 38757, and 38785.

38492 SIMPLIFIED GLUCAGON IMMUNOASSAY AND ITS USE IN A STUDY OF INCUBATED PANCREATIC ISLETS. Nonaka, Kyohei; Foa, Piero P. (Sinai Hospital, Detroit). Proc. Soc. Exp. Biol. Med., 130: 330-6(Jan. 1969).

A rapid and sensitive radioimmunoassay test for glucagon is described, in which a powdered cellulose suspension is used for the separation of free from antibody-bound glucagon. One hundred samples can be assayed conveniently in 2 days. The method was applied to the assay of glucagon in serum and in incubation media. Isolated rat pancreatic islets incubated in Krebs–Henseleit buffer containing glucose at a concentration of 300 mg/100 ml secreted glucagon at an average rate of 42 ng/10 islets/hr. When the concentration of glucose was 30 mg/100 ml the average rate of glucagon secretion was 72 ng/10 islets/hr ($p < 0.005$). (auth)

38493 STUDIES WITH THE RADIOIMMUNOASSAY FOR ANGIOTENSIN II, AND ITS APPLICATION TO MEASUREMENT OF RENIN ACTIVITY. Page, Lot B.; Haber, Edgar; Kimura, Andrew Y.; Purnode, Andre (Newton-Wellesley Hospital, Boston. Tufts Univ. School of Medicine, Boston. Massachusetts General Hospital, Boston. Harvard Medical School, Boston). J. Clin. Endocrinol. Metab., 29: 200-6(Feb. 1969).

The radioimmunoassay for angiotensin II which was previously described was revised, improved, and simplified. Plasma angiotensin II concentration in normal subjects on unrestricted sodium intake averages 21 ± 10 μμg/ml. The method may be applied to measurement of renin activity, giving average values of 0.73 ± 0.32 U/ml plasma in normal subjects. Variation in sodium intake, activity, and the administration of diuretics in normal subjects produced expected changes in both circulating angiotensin and renin activity. Anephric subjects showed absent circulating angiotensin and very low but measurable renin activities. (auth)

38494 RADIOIMMUNOASSAY OF GROWTH HORMONE BY ENZYME PARTITION. Mitchell, M. L.; Collins, Sonia; Byron, John (Lemuel Shattuck Hospital, Boston. Tufts Univ. School of Medicine, Boston). J. Clin. Endocrinol. Metab., 29: 257-64 (Feb. 1969).

A reliable and sensitive radioimmunoassay for human growth hormone was devised in which separation of antibody-bound and free radiohormone (HGH-^{125}I) was accomplished by the principle of enzyme partition. Since the proteolytic enzyme, ficin, rapidly destroys most free HGH-^{125}I, but does not degrade antibody-bound radiohormone, the two fractions could be readily distinguished by precipitation of the antibody-bound HGH-^{125}I with trichloroacetic acid solution. With this elementary system, endogenous levels of growth hormone in serum could be conveniently measured in less than 24 hr with results that were comparable in precision and sensitivity with those of longer techniques that are currently in use. The successful application of enzyme partition to the assay of growth hormone, and previously to the measurement of insulin, suggests that the same principle could be employed to assay other hormones or substances that are bound by specific antibodies or nonspecific binding substitutes. (auth)

38495 CHARACTERIZATION OF IgM AND IgG ANTIBODIES PRODUCED DURING THE ANAMNESTIC RESPONSE INITIATED IN VITRO. Godfrey, Henry P.; Yashphe, Diane J.; Coons, Albert H. (Harvard Medical School, Boston). J. Immunol., 102: 317-26(Feb. 1969).

Rabbit lymph node fragments undergoing an anamnestic response in vitro produced both 7 S (IgG) and 19 S (IgM) antibodies as well as inconstant amounts of 28 S antibodies that are presumably of IgM type. The majority of the antibodies produced were of the 7 S type, which, after 15 days of culture, represented more than 90% to 99% of the antibody activity in the fluids; however, small amounts of 19 S antibodies were present for up to 15 days in these culture fluids. Leucine, labeled with ^{14}C, was incorporated into immunoglobulins and specific antibodies and radioimmunoassay techniques were used for the detection of antibodies. While the absolute amounts of antibody activity, radioactivity incorporated, and protein increased over the course of these experiments, it was inferred that antibody is only a relatively small percentage of the newly synthesized protein that is present in the culture fluids. (C.H.)

38496 HUMORAL EFFECTS UPON THE FORMATION OF ANTIBODIES. Janev, E.; Zlatev, S.; Nedyalkov, I.; Cifcijski, S. (Higher Medical Inst., Plovdiv, Bulgaria). Folia Med. (Plovdiv), 9: 319-26(1967).

The effects of ionizing radiation on the production of hemolysins, hemagglutinins, and agglutinins in albino rats and rabbits were studied. The results of the investigations carried out in humoral and immunocytological aspects indicate that one of the mechanisms through which ionizing radiation bears an effect upon the production of antibodies, is an upset in the synthesis of a particular endogenous factor. The latter is produced in the inductive phase of antibody formation and is considered beyond doubt as necessary to the normal run of the immunogenic process. (auth)

38497 MECHANISM OF IMMUNOLOGIC TOLERANCE. I. INDUCTION OF TOLERANCE TO BOVINE γ-GLOBULIN BY INJECTION OF ANTIGEN INTO INTACT ORGANS IN VITRO. Scott, David W.; Waksman, Byron H. (Yale Univ., New Haven). J. Immunol., 102: 347-54(Feb. 1969).

Specific unresponsiveness to BγG was demonstrated in the thymectomized, x-irradiated Lewis rats restored with washed cells from intact lymphoid organs injected with soluble BγG and incubated for 2 hr in vitro. Both delayed sensitization and antibody formation against BγG were reduced in the recipient; responses to PPD and bovine γA-globulin were not affected. Unresponsiveness to soluble ovalbumin could be induced by use of the same technique. Evidence is presented that this phenomenon is not caused by the transfer of either free antigen, with the production of low-zone tolerance, or of cell-associated (membrane-bound) antigen. Since comparable unresponsiveness was not induced by incubating lymphoid cells in suspension with BγG, it is suggested that a processing step may be necessary for the production of tolerance or, alternatively, that the physiologic environment of the lymphoid cells controls their reactivity with antigen. (auth)

38498 TRANSPLANTATION OF ALLOGENEIC AND XENOGENEIC (RAT) MARROW IN IRRADIATED MICE AS AFFECTED BY RADIATION EXPOSURE RATES. Gengozian, N.; Carlson, D. E.; Allen, E. M. (Oak Ridge Associated Universities, Tenn.). Transplantation, 7: 259-73(Apr. 1969).

Mice were given 900 R or 1200 R total-body irradiation at varying exposure rates with a ^{137}Cs or ^{60}Co irradiator. Groups of mice from each exposure rate received iv allogeneic or xenogeneic (rat) bone marrow cells. Of those receiving 900 R and allogeneic marrow, increased survival above the radiation controls was not obtained in those irradiated at a rate of 3.75 R/min or 19.8 R/min; increased survival was obtained in those irradiated at a rate of 39.7 R/min or 53.4 R/min. In none of the four radiation exposure rate groups was a donor marrow graft detected in the 60-day survivors. In those mice receiving 1200 R and allogeneic marrow, increased survival above the radiation controls was obtained for the three different exposure rates studied, 3.75 R/min, 39.7 R/min, and 53.4 R/min. Only in the two higher exposure rate groups, however, was a permanent transplant of donor marrow effected. Mice receiving 1200 R at varying exposure rates followed by xenogeneic marrow treatment showed essentially the same results as in the allogeneic groups, i.e., the absence of a permanent graft in the low exposure rate group. Antibody formation directed against graft antigens (rat red blood cells) was detected in the survivors following loss of the marrow graft. In a group of experiments involving specific pathogen-free mice, evidence for a midlethal killing effect as a function of radiation exposure rate was obtained. Animals receiving 1050 or 1100 R at the low exposure rate of 3.67 R/min and then treated with rat bone marrow showed greater 30-day mortality than the radiation control groups. When the same total exposures were given at the rate of 53.4 R/min, however, the marrow caused increased survival above that of the controls. Furthermore, the low exposure rate groups showed formation of antibody directed against graft antigen following loss of the graft and also a decrease in the persistence of donor granulocytes in the bone marrow and spleen. The data strongly suggest the immune mechanism of mice to be sensitive to rates of radiation exposure; i.e., the lower the exposure rate, the greater the ability of the irradiated animal to mount an immune response leading to an incomplete take or loss of the graft and subsequent formation of antibody. These phenomena can occur even though the animal has received a 100% lethal dose and the difference in exposure time has ranged from a few minutes to a few hours. The relevance of these findings to clinical trials of marrow transplantation in irradiated patients is discussed. (auth)

38499 OBSERVATIONS ON THE SUSCEPTIBILITY OF WHITE MICE TO INFECTION WITH LEISHMANIA MEXICANA FOLLOWING WHOLE-BODY X IRRADIATION. Shaw, J. J.; Voller, A. (London School of Hygiene and Tropical Medicine). Ann. Trop. Med. Parasitol., 62: 174-7(June 1968).

Mice were exposed to 400 or 600 R whole-body x irradiation to determine the effect on susceptibility to subsequent infection with Leishmania mexicana. Five days postirradiation they were inoculated subcutaneously with a known number (about 400) of cultural forms of L. mexicana. The results indicated that the infection rate (i.e., the number of animals developing lesions) was significantly lower in the mice that received 600 R than in the controls. There was no significant difference in infection rates between the controls and the 400 R group. A higher proportion of the mice in the group receiving 600 R developed large lesions than in the controls, but this was not statistically significant. In previous experiments on infection with Trypanosoma duttoni, the infection was much more virulent in the irradiated animals than in the controls. This was in sharp contrast to the present results since the mice appeared to be rendered more resistant to L. mexicana infection by previous irradiation, although there was a tendency for the lesions, once established, to be larger in the irradiated animals than in the controls. Consideration of the mode of the development of infections with the parasite may explain the unexpected findings. Leishmania species in mammals are obligate parasites of macrophages, cells that are concerned in the immunological response of the host. Irradiation reduces the total number of macrophages and inhibits the digestion of phagocytosed material. The reduction in macrophages might account for the reduced infection rate of L. mexicana in the highly irradiated animals of the present study. The reduced antibody response may allow greater development of the lesions once they are established in the irradiated animals. (BBB)

38500 HEMOPOIETIC PROGENITOR CELLS OF W ANEMIC MICE STUDIED IN VIVO AND IN VITRO. Bennett, M.; Cudkowicz, G.; Foster, R. S. Jr.; Metcalf, D. (Roswell Park Memorial Inst., Buffalo). J. Cell. Physiol., 71: 211-26(June 1968).

To investigate the relation between the progenitor cells that repopulate the spleen of irradiated mice and those that give rise to colonies in culture, the frequency of these two types of cells in bone marrow was compared in mice with hereditary anemia by mutant alleles at the W locus. Hemopoietic marrow cells of such mice (genotype W^v/W) are grossly deficient in producing erythroid progeny upon transplantation into heavily irradiated recipients. Recipient mice for in vivo experiments were exposed to 750 to 900 R of x radiation. Marrow from anemic and nonanemic carrier mice contained progenitor cells that were decreased in number and formed small, often rudimentary, colonies in the spleens of irradiated recipient mice. Proliferation and differentiation of both erythropoietic and leukopoietic progenitor cells were delayed and reduced, but erythropoiesis was more severely affected than leukopoiesis. The severity of the hemopoietic impairment was gene-dose dependent. The W gene effect on leukopoietic progenitor cells was not secondary to anemia or to abnormal erythropoiesis. The marrow cells of anemic and carrier mice that form colonies of granulocytic and mononuclear cells in vitro were neither decreased in number nor impaired in proliferation and differentiation. Hypertransfusion of red blood cells increased the frequency of in vitro colony-forming cells, but not that of in vivo progenitor cells. The data demonstrated that colony-forming cells that proliferate in the agar gel cultures in vitro are distinct from the in vivo colony-forming cells and suggest that the former are primitive members of the granulocytic cell line. Perhaps in vitro CFU are in an intermediate stage of differentiation between in vivo CFU and myeloblasts, analogous to that which was suggested for the erythropoietin-sensitive cell in the red cell series. W mutant alleles appear to act, therefore, at or very near the beginning of hemopoietic differentiation. (BBB)

38501 RADIATION-INDUCED DEPRESSION OF PRIMARY AND SECONDARY ANTIBODY RESPONSES TO BACTERIOPHAGE φ X 174 IN VITRO. Tao, T.; Leary, P. L. (Harvard Medical School, Boston). Nature (London), 223: 306-8(July 19, 1969).

It was known that whole-body x-irradiation may depress or enhance antibody response, depending on the dose and its time relation to injection of antigen in an animal. A study is described, using organ cultures of rabbit lymph nodes in which both primary and secondary types of antibody response to bacteriophage φ X 174 were initiated in vitro, to determine the effect of irradiation on the antibody responses. For studies of primary antibody response tissues from non-immunized rabbits were used; and for secondary response tissues were taken from rabbits which had received an intravenous injection of the bacteriophage more than 6 weeks before killing. Cultures were irradiated 1 day before to 2 days after introduction of antigen, the x-radiation dose ranging from 50 to 1,000 R. Both types of responses were depressed by the irradiation, the extent of depression being dose and time dependent. The latent period appeared unaffected, and irradiation had little effect once antibody formation was initiated. Lymph node cultures never showed the irradiation induced enhancement of primary antibody response seen in the whole animal. In the rat and guinea-pig receiving 500 R 2 hr to 24 hr after injection of φ X 174 an enhancement of the response was seen within 1 to 2 weeks. Possible reasons for the difference between the in vitro and in vivo behavior are suggested. So far as the basic mechanisms of antibody formation are concerned there appeared to be no difference in radiosensitivity of cells involved in the two types of response, regardless of cell type. (UK)

38502 QUANTITATIVE AND QUALITATIVE ANALYSIS OF THE INDUCTION OF SPECIFIC IMMUNOLOGIC UNRESPONSIVENESS IN ADULT MICE. Muramatsu, Shigeru; Kawaguchi, Susumu (Kyoto Univ.). Mem. Fac. Sci., Kyoto Univ., Ser. Biol., 2: 61-71(Sept. 1968).

Nonaggregated solution of a purified fraction of bovine γ-globulin was not immunogenic but induced specific immunologic unresponsiveness. No significant difference was found between normal and x-irradiated mice with respect to the amount of antigen required for inducing the unresponsiveness. The same antigen incorporated into Freund's adjuvant was highly immunogenic to interfere with the immunosuppressive action of the nonaggregated antigen. The physical form of antigen and the concentration in the extracellular space seem much more important factors than the population of the immunologically competent cells in the induction of unresponsiveness. (auth)

38503 CELLS INVOLVED IN THE IMMUNE RESPONSE. VI. THE IMMUNE RESPONSE TO RED BLOOD CELLS IN IRRADIATED RABBITS AFTER ADMINISTRATION OF NORMAL, PRIMED, OR IMMUNE ALLOGENEIC RABBIT BONE MARROW CELLS. Abdou, Nabih I.; Richter, Maxwell (McGill Univ. Clinic, Montreal). J. Exp. Med., 129: 757-74(Apr. 1, 1969).

Irradiated (800 R ^{60}Co γ) rabbits given allogeneic bone marrow cells from normal adult donors responded to an injection of sheep red blood cells by forming circulating antibodies. Their spleen cells were also capable of forming many plaques using the hemolysis in gel technique, and were also capable of undergoing blastogenesis and mitosis and of incorporating tritiated thymidine upon exposure to the specific antigen in vitro. However, irradiated rabbits injected with allogeneic bone marrow obtained from rabbits injected with sheep red blood cells 24 hr prior to sacrifice (primed donors) were incapable of mounting an immune response after stimulation with sheep red cells. This loss of reactivity by the bone marrow from primed donors is specific for the antigen injected, since the immune response of the irradiated recipients to a non-cross-reacting antigen, the horse red blood cells, is unimpaired. Treatment of the bone marrow donors with high-titered specific antiserum to sheep red cells for 24 hr prior to sacrifice did not result in any diminished ability of their bone marrow cells to transfer antibody-forming capacity to sheep red blood cells. The significance of these results, with respect to the origin of the antigen-reactive and antibody-forming cells in the rabbit, is discussed. (auth)

38504 CELLS INVOLVED IN THE IMMUNE RESPONSE. XI. IDENTIFICATION OF THE ANTIGEN-REACTIVE CELL AS THE TOLERANT CELL IN THE IMMUNOLOGICALLY TOLERANT RABBIT. Abdou, Nabih I.; Richter, Maxwell (Royal Victoria Hospital, Montreal). J. Exp. Med., 130: 165-84(July 1, 1969).

Rabbits were made immunologically tolerant to either human serum albumin or bovine gamma globulin by the neonatal administration of antigen. At 10 wk of age, they were challenged with the tolerogenic antigen and found to be nonresponsive. However, these tolerant rabbits could respond with humoral antibody formation directed toward the tolerogenic antigen if they were treated with normal, allogeneic bone marrow or bone marrow obtained from a rabbit made tolerant toward a different antigen. They were incapable of responding if they were given bone marrow obtained from a rabbit previously made tolerant to the tolerogenic antigen. Irradiated rabbits were unable to respond if treated with tolerant bone marrow, but could respond well if given normal bone marrow. Since it has previously been demonstrated that the antibody-forming cell, in an irradiated recipient of allogeneic bone marrow, is of recipient and not donor origin, the data presented strongly indicate that the unresponsive cell in the immunologically tolerant rabbit is the antigen-reactive cell. (auth)

38505 CELLS INVOLVED IN THE IMMUNE RESPONSE. X. THE TRANSFER OF ANTIBODY-FORMING CAPACITY TO IRRADIATED RABBITS BY ANTIGEN-REACTIVE CELLS ISOLATED FROM NORMAL ALLOGENEIC RABBIT BONE MARROW AFTER PASSAGE THROUGH ANTIGEN-SENSITIZED GLASS BEAD COLUMNS. Abdou, Nabih I.; Richter, Maxwell (Royal Victoria Hospital, Montreal). J. Exp. Med., 130: 141-63(July 1, 1969).

The antigen-reactive cells in normal rabbit bone marrow were isolated from a suspension of marrow cells by passage of the cells

through an antigen-sensitized glass bead column. The cells that passed through the column were deficient in antigen-reactive cells directed to the antigen used to sensitize the glass beads, whereas the cells eluted from the column could transfer antibody-forming capacity to irradiated recipients only with respect to the specific sensitizing antigen. Separation of the bone marrow antigen-reactive cells was not achieved by passage of the cells through nonsensitized glass bead columns or in the presence of excess free antigen in the column. Cells that were retained by, and later eluted from, the antigen-sensitized glass bead columns were mostly small mononuclear cells, whereas cells that passed through the columns were morphologically similar to the original unfractionated bone marrow cell suspension. The data indicate the presence of an antibody or antibody-like structure, with defined immunological specificity, on the surface of the normal bone marrow antigen-reactive cell. (auth)

38506 THE EFFECT OF CYTOTOXIC AGENTS ON THE PASSIVE TRANSFER OF CELL-MEDIATED IMMUNITY. Tripathy, S. P.; Mackaness, G. B. (Trudeau Inst., Saranac Lake, N. Y.). J. Exp. Med., 130: 17-30(July 1, 1969).

A system involving the passive transfer of committed lymphoid cells from Listeria-immune donors was used to study the phases of the immune response that are sensitive to the immunosuppressive action of cytotoxic agents. The agents investigated included cyclophosphamide, vinblastine, methotrexate, azathioprine, and x irradiation. Complete suppression of passive immunization was obtained by the administration of cyclophosphamide or vinblastine to recipients at the time of cell transfer or by prior x irradiation of recipients a day before cell transfer. Methotrexate was only partially suppressive, whereas azathioprine had no effect at all. The donor cell responsible for the transfer of immunity to recipients was shown to be a resting cell that was sensitive to the action of cyclophosphamide but not to vinblastine. The results of this investigation suggest that the donor cells undergo multiplication in the tissues of the recipient, presumably in response to specific stimulation by Listeria antigens. This in turn results in the activation of host macrophages. The immunosuppressive action of cyclophosphamide, vinblastine, and irradiation in the cell-transfer system was discussed in relation to a direct cytotoxic action on the immune lymphoid cells of the donor and specific interference with their proliferation in the recipient, as well as impairment of macrophage production on the part of the recipient itself. (auth)

38507 EARLY SECONDARY DISEASE IN THE RHESUS MONKEY. I. A COMPARATIVE HISTOPATHOLOGIC STUDY. Woodruff, James M.; Eltringham, James R.; Casey, Harold W. (Air Force School of Aerospace Medicine, Brooks Air Force Base, Tex.). Lab. Invest., 20, 499-511(June 1969).

Monkeys lethally γ-irradiated and transfused with allogeneic bone marrow developed degenerative lesions attributable to allografted marrow cells between six and eight days post-treatment. By day four, a majority of lymph nodes from allografted animals was repopulated by small lymphocytes and contained scattered large immunoblasts; necrosis was common after day eight and was associated with a striking infiltration of hyperbasophilic medium lymphocytes. Necrosis of epithelial tissue appeared first in the liver, at day six, in which lymphocytic infiltration and focal necrosis were prominent after day eight. Epithelium of involved oral, esophageal, and cervical mucous membranes as well as the pilosebaceous apparatus of the skin showed extensive intraepithelial migration of hyperbasophilic lymphocytes, spongiosis, focal acantholysis and "satellite cell dyskeratosis." Patchy crypt disintegration, associated with cytorrhexis of infiltrative donor lymphocytes and epithelial cell autolysis, characterized changes in the mucosa of both small and large intestines. Purely infiltrative lesions were seen in the lung, myometrium, and epididymis of some animals. Although regeneration was noted in all involved epithelia, extensive acanthosis and hyperkeratosis of the skin were not seen. The initial degenerative changes of secondary disease of the monkey appear exclusively in epithelial tissues, a finding attributed to the effect of foreign, sensitized medium lymphocytes, intended for intraepithelial migration. (auth)

38508 LOCAL PROTECTION AGAINST X-IRRADIATION BY DIMETHYLSULPHOXIDE. Dod, J. L.; Shewell, Jennifer (St. Mary's Hospital Medical School, London). Brit. J. Radiol., 41: 950(Dec. 1968).

Twenty minutes pre-treatment with topically applied dimethylsulfoxide was shown to produce a slight but significant protection against x-radioinduced epilation in 16-day-old rats. Fifteen minutes pre-treatment produced more variable results. (C.H.)

38509 RECENT DEVELOPMENTS IN TRANSPLANTATION IMMUNOLOGY. PART I. Billingham, Rupert E.; Barker, Clyde F. (Univ. of Pennsylvania, Philadelphia). Plast. Reconstr. Surg., 43: 559-68(June 1969).

Selected immunological aspects of organ transplantation are reviewed as an indication of current problems and future possibilities. Current understanding of the role of lymphocytes in homograft destruction is outlined. Antigen-sensitive (or immunologically competent) cells are included in the pool of long-lived small lymphocytes that are constantly recirculating from blood to lymph via the post-capillary venules in the nodes. Procedures that deplete an animal's pool of recirculating lymphocytes (such as thoracic duct drainage, whole-body irradiation or extracorporeal irradiation of its blood or lymph) weaken its capacity to reject homografts. When antigen-sensitive lymphocytes are confronted by alien transplantation-antigens a small proportion are activated. As a result of this specific event, they settle in lymphoid tissues, predominantly in the regional nodes. Here, they transform into large pyroninophilic cells or immunoblasts that are believed to constitute effector cells. The possibility that leukocytes (probably of the mononuclear series and inadvertently transferred in the vasculature of organ and tissue homografts) may provide a significant antigenic stimulus to a recipient is also considered. These cells are responsible for inciting the development of both the normal and the immune lymphocyte transfer reactions (manifestations of local graft-vs-host (GVH) reactivity) when lymphocytes are injected into the skins of homologous hamster hosts. For example, whole-body irradiation of hosts (1500 R, that caused significant leukopenia) prior to transfer of donor lymphoid cells resulted in greatly attenuated transfer reactions. The relatively few passenger donor leukocytes harbored in the vasculature of a free skin graft are sufficient to incite sensitivity. Using radiochimeric mice it was found that transfer of free skin grafts from the tolerant animals to normal hosts of the same strain sensitized the latter against tissue antigens of the strain that donated the tolerance-conferring inoculum. However, the sensitizing capacity of the skin isografts was found to be greatly diminished if they were removed from chimeric mice previously made leukopenic by heavy whole-body irradiation. It is concluded that particulate antigen, passenger cells, and peripheral sensitization are all operating to prevent permanent acceptance of the homografts. In many situations, any one of these components may be sufficient to provoke rejection. (BBB)

38510 GRAFT REACTION IN TISSUE CULTURE. III. EFFECT OF PHYTOHEMAGGLUTININ. Berke, G.; Ginsburg, H.; Feldman, M. (Weizmann Inst. of Science, Rehovoth, Israel). Immunology, 16: 659-67(May 1969).

The effect of a lymphocyte-transforming agent was tested using rat lymphocytes assayed in x-irradiated cultures of mouse fibroblasts. Rat lymphocytes cultured on mouse embryo fibroblast monolayers transformed and differentiated to large pyroninophilic cells (LPC) that lysed the irradiated mouse fibroblasts. Exposure to phytohemagglutinin (PHA) induced the development of a different type of culture culminating in a population of medium-size lymphoid cells. The sensitization of rat lymphocytes to the mouse cell antigens was blocked by adding PHA. The resulting cells were unable to lyse the irradiated mouse fibroblasts. PHA, added at any time up to 72 hr after plating, also blocked sensitization; added to a population of mature LPC, it clumped the cells and markedly decreased the lytic process. (BBB)

38511 GRAFT REACTION IN TISSUE CULTURE. II. QUANTIFICATION OF THE LYTIC ACTION ON MOUSE FIBROBLASTS BY RAT LYMPHOCYTES SENSITIZED ON MOUSE EMBRYO MONOLAYERS. Berke, G.; Ax, W.; Ginsburg, H.; Feldman, M. (Weizmann Inst. of Science, Rehovoth, Israel). Immunology, 16: 643-57(May 1969).

A method for assaying the lytic action of large pyroninophilic cells (LPC) in cultures of rat lymphocytes on x-irradiated target fibroblasts in mouse embryo monolayers is described. The 24-hr fibroblast cultures were irradiated with 2000 R and used the next day for plating the lymphocyte suspension. The basis of the assay was the labeling of fibroblasts with ^{51}Cr. The rate of ^{51}Cr release to the medium was proportional to the number of LPC and expressed precisely the actual number of lysed fibroblasts. The lytic activity in LPC suspension was expressed by the lysis index that is the number of LPC per fibroblast lysed at 50% lysis. A suspension of LPC collected 5 to 6 days after exposure of rat lymphocytes to the mouse monolayers showed a lysis index ranging from 0.7 to 1.3 after 16- to 48-hr of incubation. The lytic power of a culture was expressed by a value that was obtained by dividing the total number of LPC in a culture by the index. This determined the total number of fibroblasts lysed if the whole culture content were distributed among plates of test monolayer in such a way as to produce 50% lysis in all the plates. (BBB)

38512 KINETICS OF ANTIBODY FORMATION. Uhr, J. W.; Finkelstein, M. S. (New York Univ., N. Y.). Progr. Allergy, 10: 37-83(1967).

Effects of ionizing radiation and other physical and chemical agents on antibody synthesis are reviewed. Sufficient doses of x rays given 24 hr before injection of protein antigen into rabbits prevented the primary antibody response; similar doses of x rays given 12 or more hr after injection of antigen did not depress primary antibody formation. Soon after antigenic stimulation, potential antibody-forming cells enter a radioresistant phase. If, however, the interval between injection of antigen and subsequent irradiation is properly adjusted for the specific antigen, an effect on antibody formation can be achieved. The differential effects of radiation upon the 19S and 7S primary responses have been investigated. Irradiation before ΦX or T_2 bacteriophage immunization of rabbits depressed the 19S response and prevented the development of a 7S response. A 600- to 700-R whole-body dose to rabbits 24 hr before immunization delayed the onset of 19S formation, slowed the kinetics and reduced the peak titer 98%, and prolonged the duration of 19S formation; 7S formation was not detected. A dose of 400 R 24 hr after immunization prolonged the duration of synthesis of 19S and increased peak titers of both 19S and 7S. The 7S system (and to a lesser extent the 19S system) becomes relatively radioresistent between 2 to 24 hr after immunization, probably because the cells responsible for 7S antibody formation have already been stimulated to begin their differentiation. The secondary 7S antibody response appears to be less affected by irradiation as compared to the primary one, particularly when soluble as contrasted to particulate antigens are used. The stimulating effect of irradiation after antigen injection may be primarily caused by the radioinduced depletion of lymphoid tissue, which allows a disproportionate replication in these tissues by surviving antigen-stimulated cells. Liberation of nucleic acid precursors may be another important factor, as seen from observations that DNA-containing preparations can restore antibody-forming capacity to irradiated animals. (BBB)

38513 STUDIES ON THE IMMUNOLOGICAL POTENTIALITY OF IRRADIATED ECHINOCOCCUS GRANULOSUS FORMS: IMMUNIZATION EXPERIMENTS IN DOGS. Movsesijan, M.; Sokolic, A.; Mladenovic, Z. (Inst. for the Application of Nuclear Energy in Agriculture, Veterinary Medicine, and Forestry, Zemun, Yugoslavia). Brit. Vet. J., 124: 425-32(Oct. 1968).

A radiation-attenuated vaccine for E. granulosus was tested in dogs to investigate such variables as radiation dose, larval number, single and double vaccine administration, and time interval between various vaccination procedures in the immunization schedule. Larvae were irradiated by 20, 25, and 30 KR of x rays. The results showed that it was possible to produce a high degree of protection (from 58 to 92%) from E. granulosus infection by administering larvae of this worm irradiated at any of these dose levels. The size of the immunizing dose was found to be an important immunity-producing factor, as shown by comparing the results of a 1000-larva dose with 2000. Protection with these two doses was 58 and 80.5% respectively. When 3000 larvae were given as two doses (1000 + 2000) separated by 15 days there was a marked reduction of immunity when expressed as total worm burden and it seemed that with the time intervals in this experiment there was a temporary impairment of immunity resulting from the second dose of vaccine. However, immunity was manifested in the double-vaccinated group in terms of the small proportion of mature worms in the vaccinates (4.5% as compared with 83.5% in controls). The oral route of antigen administration was suitable in inducing immunity to E. granulosus. (BBB)

38514 RESTORATION OF IMMUNOLOGIC FUNCTIONS IN RADIATION-CHIMERAS FOLLOWING LOCAL THYMUS IRRADIATION. Schnyder, Thomas (CIBA Aktiengesellschaft, Basel). Strahlentherapie, 137: 578-95(May 1969). (In German).

The effect of irradiation of the thymus, on the restoration of the thymus dependent reactions after a total body irradiation and syngeneic bone marrow therapy, was studied in mice by different histological, hematological, and immunological parameters. Previous local irradiation of the thymus with 1000 or 2000 R caused a weakened regeneration of the lymphoid tissue and immunological reactivity. Other more pronounced deficiency symptoms were observed in adult thymectomized radiation-chimeras. The deficiencies in these animals could be partially compensated by an intact thymus graft. When this graft was previously irradiated in vitro with 1000 or 2000 R, it was much less active. (auth)

Ecology

38515 (AERE-R-6061) USE OF GAMMA RADIATION IN SOIL RESEARCH. Cawse, P. A. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). Apr. 1969. 20p. Dep. CFSTI. UK 3s. 6d.

In agricultural research practice it has been found that there are several clear advantages in using radiation rather than heat or chemicals to sterilize or partially sterilize soil. Radiation has already been applied to many delicate experiments on such topics as enzyme behavior, degradation and adsorption of organic compounds by soil, colonization of selected microorganisms in sterile soil, nitrogen mineralization and nitrate reduction, microfauna activities, uptake of nutrients by sterile plants, and soil aggregation. Irradiation of plants in γ fields has prompted several studies on the overall response of the soil ecosystem. Although radiation is a relatively new tool for soil research, by virtue of its successful application to a wide variety of problems the technique should find increasing application to many future programs; to this end some suggestions are put forward in the present review. (auth) (UK)

38516 (ANL-7559) ECOLOGICAL SURVEY OF ARGONNE NATIONAL LABORATORY. Messenger, A. Steven; Suter, Walter R.; Wagner, John A. (Argonne National Lab., Ill.). Mar. 1969. Contract W-31-109-eng-38. 58p. Dep. CFSTI.

A biological inventory was taken on the grounds of Argonne National Laboratory, primarily during the summer of 1967, as a preliminary to beginning a program of ecological research at the Laboratory. This report contains checklists of the major plants and animals on the site, a vegetation association map, a quantitative survey of old-field quadrats, and a list of known prairie relicts of the Chicago region. The species checklists are not complete, but show nearly 200 species of plants and over 800 species of animals on approximately 3500 acres of the laboratory property, of which 1275 are devoted to laboratory operations. The remainder is largely unmanaged land in various stages of old-field succession or in coniferous and deciduous forests. The coniferous trees occur as introduced plantations consisting largely of jack pine (Pinus banksiana) whereas the deciduous forests are mainly naturally occurring oak (Quercus spp.), associations that may have been utilized as grazed woodlots when the area was devoted to agriculture. The oil fields are dominated by weedy Eurasian annual and perennial grasses and forbs, with occasional mixtures of agricultural grasses and surviving native prairie grasses and forbs. The old fields are apparently returning to a deciduous forest climax. There are no examples of native undisturbed climax vegetation, with the possible exception of isolated ponds and marshes in remote locations which were unsuitable for agricultural exploitation. (auth)

38517 PROBLEMS RELATING TO THE RADIOECOLOGY AND CHEMICAL ECOLOGY OF MARINE ORGANISMS. Polikarpov, G. G. (Inst. of Biology, Sevastopol, USSR). Oceanology (USSR) (Engl. Transl.), 7: 435-43(1967).

Two approaches to the phenomenon of radioactivity have developed in biological oceanography: radioactivity as a subject of study and as a method of studying other processes, or marine radioecology and chemical ecology of marine organisms. The history of these fields, especially in the U.S.S.R. is reviewed, with an overview of division of current research. The structure of marine radioecology covers at least two main areas. One comprises the processes of interaction between radioactive hydrobionts and others. These processes include the biogenous migration of radionuclides, and their biological effect, and also the ensuing ecological modifications. The other area comprises the interaction between hydrobionts and the radioactive environment. It may be subdivided into radioactive external organic and inorganic metabolites and radioactive nonmetabolites. General aspects of radionuclide distribution between aquatic biocoenoses and the aqueous medium are discussed. In the area of marine radioecology connected with the effect of radioactive substances on populations and associations and on their biological productivity, the factual information that has been accumulated is not yet adequate for generalizations or rules. Analysis of the state of research in adjacent areas demonstrates that the time is now ripe for formulation of the scope of the chemical ecology of marine organisms. The scope of the radiation and chemical ecology of marine organisms is diagrammed. (48 references) (BBB)

38518 THE INFLUENCE OF STABLE AND RADIOACTIVE STRONTIUM ON FRESH WATER ORGANISMS. Lebedeva, G. D. (Inst. of Biophysics, Moscow). Gidrobiol. Zh., Akad. Nauk Ukr. SSR, 4: No. 4, 3-10(1968). (In Russian).

The effect of stable and radioactive Sr on Leucaspius delineatus, Cyprinus carpio, Daphnia magna, Lemna minor, and Scenedesmus quadricauda was determined. Radioactive Sr, like stable Sr, shows different influences on different species. The most sensitive species of those studied was Daphnia. With respect to this species, 5×10^{-10} Ci/l of ^{90}Sr may be considered a harmless concentration.

The radiation resistance of different ecological and systematic aqueous organisms to ^{90}Sr is a result of the inverse dependence on time and the level of accumulation of ^{90}Sr in these organisms. This coefficient of accumulation at a level of 1×10^{-7} Ci/l is 1000 in Scenedesmus, 100 in Lemna, 70 to 80 in Daphnia, and 10 to 20 in the fishes studied. Daphnia is likewise the most sensitive to stable Sr, the safe level being 5 mg/l for stable Sr; the toxicity of ^{90}Sr is thus not a chemical effect but a radioactive one. (BBB)

38519 DATA FOR ASSESSMENTS CONCERNING CONTROLLED AND ACCIDENTIAL RELEASES OF ^{131}I AND ^{137}Cs TO ATMOSPHERE. Bryant, Pamela M. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Health Phys., 17: 51-7(July 1969).

A review is given of the current situation regarding selection of parameters from metabolic, dosimetric and agricultural data needed to provide limits of contamination applicable in the vicinity of nuclear energy establishments. Such limits are required for use in assessments concerning controlled and accidental releases to atmosphere. Within the generalized term "limits," the term "derived working limit" is applied to situations connected with controlled releases, and "emergency reference level" to accidental releases. Derivation of limits for ^{131}I and ^{137}Cs in diet, on pasture and in air is discussed; values given for ^{131}I are recommended for use in the United Kingdom by the U. K. Medical Research Council. (auth) (UK)

38520 MICROBIAL IMMOBILIZATION OF ^{137}Cs IN FOREST LITTER. Witkamp, Martin; Barzansky, Barbara (Atomic Energy Commission, Oak Ridge, Tenn.). Oikos, 19: 392-5(1968). (ORNL-P-3610).

By a comparison of loss of ^{137}Cs from sterile leaves with that from leaves with active microbial growth, measurements were made of immobilization of an isotope in forest litter. Leaves of tulip poplar (Liriodendron tulipifera) were exposed on threads in the forest floor of a tulip poplar stand, part of which had been tagged with ^{137}Cs. After 6 weeks of incubation in the stand with ^{137}Cs, untagged leaves with active microflora contained more ^{137}Cs than leaves without microflora. In the stand without ^{137}Cs, leaves with microflora retained more ^{137}Cs than those without. These results suggest immobilization of ^{137}Cs by the microbiota on the leaves. Average retention by decaying and sterile leaves was 51% and 45% of the initial ^{137}Cs content. Thus net immobilization was 7% of the initial content and about double that for the average content during the experiment. It is suggested that microbial immobilization is a factor in the natural cycle of ^{137}Cs fallout in forested landscapes. (BBB)

38521 FOLIAR APPLICATION OF ^{137}Cs ON UNDERSTORY SPECIES OF MESIC FOREST. Whitford, Philip B. (Univ. of Wisconsin, Milwaukee). Radiat. Bot., 8: 509-13(Dec. 1968).

Foliar application to the understory in a Liriodendron forest of 35 $\mu Ci/m^2$ of ^{137}Cs diluted in 1 l/m^2 water showed 18 per cent retention of the isotope on foliage after 2 hr, 9, 8 and 7 per cent after 2, 4, and 6 weeks (the major part of the applied solution dripped on to the litter layer). Approximately 22 cm of rain during the test period accounted for most of the reduction in isotope in the foliage, as well as for transfer through the litter to the top 5 cm of soil (23 per cent of application) by the end of the sixth week. Less than 4 per cent was absorbed and translocated to stem and roots. Differences between species are probably related to leaf surface structure, mass/area ratio, and leaf orientation. (auth) (UK)

Genetics and Cytogenetics

Refer also to abstracts 38793, 38881, 38883, 38884, and 38886.

38522 (A-AC-82/G/L-1099) PRELIMINARY REPORT ON X-RAY INDUCTION OF RECESSIVE LETHALS IN MOUSE SPERMATOGONIA. Luening, K. G.; Sheridan, William (Stockholm Univ. (Sweden). Lab. of Radiation Genetics). [1965]. 5p. Dep.

The effect of low doses of x radiation in single or multiple exposures on the incidence of recessive lethals was studied in mice. On 55 consecutive days inbred 25 to 80 day-old male CBA mice were exposed to 5R per day; another group was given a single dose of 275R. Males were mated to untreated females 70 days after the last irradiation. Some of these females were allowed to give birth to their litters, while others were killed 17 or 18 days after mating for analyses of intra-uterine death. The rate of intra-uterine death was 10.67% for the single 250R dose, 7.92% for the multiple doses, and 7.63% for the controls. The F_1 males from litters with irradiated fathers were also bred to untreated females to test for semisterility. The resulting intra-uterine death rates were 7.54% when the male had received a single 250R dose, 8.56% for those receiving multiple doses, and 6.54% in the controls. In order to test for recessive lethals the F_1 males were mated to their daughters (F_2). The rates of intra-uterine deaths in this series were 8.21% (275R), 8.45% (55 × 5R), and 9.32% (controls). It was concluded that neither dose regimen increased the rate of recessive lethals. (M.M.B.)

38523 (NYO-4052-1) PROGRESS REPORT I, 1 OCTOBER 1968-30 APRIL 1969. Lisco, Harmann (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.). Contract AT(30-1)-4052. 12p. Dep. CFSTI.

A model system of breast tumor induction was developed in rats. The rats were divided into four groups and treated as follows: DMBA alone; bilateral adrenalectomy on day 7 to 14 post DMBA; pituitary transplant from normal donor rat on day 6 post DMBA; combined adrenalectomy and pituitary transplant on day 6 post DMBA. At 50 days after DMBA the incidence of animals with breast cancer in the four groups was as follows: 14% in group one; 35% in group two; 35% in group three; and 73% in group four. At 80 days after DMBA the incidence rose to 45, 60, 70, and 85% respectively. Cell proliferation studies of tumors labeled with ^{3}H-thymidine are now being conducted. Chromosome aberrations were studied in people following administration of hallucinogenic drugs. Controls consisted of 30 individuals not exposed to drugs or other chemicals. The data show that in the 3000 cells of the control population the incidence of chromosome aberrations was 0.53%. In the 5989 cells of the drug users the incidence of aberrations was 3.14%, a six-fold increase over the controls. Patients with fracture of the femoral neck were injected with ^{3}H-thymidine for labeling proliferating cells at the site of injury. Blood samples for chromosome studies were obtained prior to injection and at intervals thereafter. No increase in aberration rates over pre-injection levels was observed. Employees of a company engaged in the manufacture of radioactive chemicals were examined for aberrations in chromosomes of leukocytes. Results indicated that aberration rates were in excess of those found in the general population. Follow-up studies were conducted on two individuals involved in a radiation accident while handling a multicurie source of iridium-192; both individuals continued to show elevated aberration rates. Cervical cancer patients exposed to intracavitary radium plus cobalt and betatron therapy showed an increase in chronic myelogenous and acute leukemia. (H.L.W.)

38524 (ORO-3728-2) [A QUANTITATIVE STUDY OF THE MUTAGENIC EFFECT OF TRANSMUTATION IN DROSOPHILA AND THE HONEY BEE]. Annual Progress Report. Lee, William R. (Louisiana State Univ., Baton Rouge). June 14, 1969. Contract AT(40-1)-3728. 7p. Dep. CFSTI.

Progress is reported on experiments designed to determine the genetic consequences of carbon-14 incorporated into DNA of Drosophila melanogaster. Preliminary results are described on feeding larvae with thymidine labeled with tritium or carbon-14. The results of experiments on ethyl methanesulfonate-induced mosaics are summarized and their significance for transmutation studies are discussed. (M.M.B.)

38525 (UCRL-71493) SECOND REPORT ON THE CHROMOSOME SCANNING PROGRAM AT THE LAWRENCE RADIATION LABORATORY. Stone, Stuart P.; Littlepage, James L.; Clegg, Bruce R. (California Univ., Livermore. Lawrence Radiation Lab.). May 14, 1969. 27p. (CONF-690616-1). Dep. CFSTI.

From Pattern Recognition Studies Seminar, New York.

During the past two years, the LRL Chromosome Group has developed a production-line system for its low-dose radiation studies using a FIDAC film reader and a collection of pattern-recognition, data-handling and statistical programs. Changes in the LRL computer facilities require the conversion of all computer programs and the attachment of our image-processing equipment to a large time-shared computer, a CDC-6600. (auth)

38526 THE INACTIVATION OF BACILLUS SUBTILIS TRANSFORMING DNA BY MUTAGENIC AGENTS. Kapadia, R. T.; Srogl, M. (Inst. of Microbiology, Prague). Folia Microbiol. (Prague), 14: 51-3(1969).

The inactivation of three genetic markers in B. subtilis transforming DNA by uv radiation, nitrous acid, and hydroxylamine was studied. The uv source was a Phillips TUV 30-W lamp. At a distance of 20 cm the lamp emitted 47 erg/mm^2. Under uv irradiation the methionine marker was the most resistant. The adenine and leucine markers were inactivated to the same extent. The reason for this result might be the different degree of inactivation of markers according to their guanine-cytidine (GC) content. As the uv action on DNA is believed to be caused by the formation of thymine dimers, the methionine marker should have a higher GC content than the other 2 markers. However, this is not in agreement with previous results with the same markers, where the fractionation of B. subtilis DNA on a methyl-

ated albumin column and the subsequent estimation of the GC content and transforming activities showed a high GC content in fractions with high transforming activity for the adenine marker. A possible explanation of this discrepancy is that the uv action not only depends on the overall base composition of markers but also on the sequent of adenine-thymine (AT) pairs. The inactivation of markers by uv and HNO_2 was marker specific, whereas hydroxylamine inactivated the markers to approximately the same degree. (BBB)

38527 PROCEEDINGS OF THE THIRD INTERNATIONAL CONGRESS OF HUMAN GENETICS, HELD AT THE UNIVERSITY OF CHICAGO, SEPTEMBER 5–10, 1966. Crow, James F.; Neel, James V. (eds.). Baltimore, The Johns Hopkins Press, 1967. 594p. $14.50. (CONF-660698).

A separate abstract was prepared for one chapter of the conference. Thirty-nine additional chapters are included on various aspects of clinical genetics, cytogenetics, biochemical genetics, immunogenetics, human evolution, and population genetics. (H.L.W.)

For an abstract of the individual chapter see: 38528.

38528 AUTORADIOGRAPHIC STUDIES OF HUMAN CHROMOSOMES. I. A REVIEW. German, James (Cornell Univ. Medical Coll., New York). pp 123-36 of Proceedings of the Third International Congress of Human Genetics. Crow, James F.; Neel, James V. (eds.). Baltimore, The Johns Hopkins Press, 1967.

From Third International Congress of Human Genetics, Chicago, Ill. See CONF 660968.

Limitations in techniques presently employed in human cytogenetics are emphasized. In addition to morphological analysis, other methods employed in the study of human chromosomes include computer analysis, electron microscopy, fluorescent staining, special metaphase blockades, and attempts to induce polyteny, puffing, and pairing. Autoradiography as a new method for analysis of human chromosomes of lymphocytes and surgically removed tissues treated with ^{3}H-thymidine is discussed. The significance of asynchronous synthesis of DNA in human chromosomes is considered. Heterochromatin of human chromosomes, genetic inactivation, and asynchrony of replication are reviewed. A review is given of autoradiographic characterization of normal and abnormal human chromosomes. (H.L.W.)

38529 THE RELATIONSHIP BETWEEN AGEING AND CANCER: SOMATIC MUTATIONS OR BREAKDOWN OF HOST DEFENCE MECHANISMS. Alexander, Peter (Chester Beatty Research Inst., Belmont, Eng.). Bull. Schweiz. Akad. Med. Wiss., 24: 258-71(Jan. 1969).

The possible relation between physiological and pathological processes in ageing and cancer, and the evidence from radiobiology pertinent to this relation, are reviewed. The finding that ionizing radiations, which are capable of inducing mutations, shorten the life-span of animals constitutes the principal experimental evidence of the proponents of the somatic mutation hypothesis for ageing. The fallacy in the argument is that an increase in the rate of mortality cannot ipso facto be equated to an increase in the rate of ageing. Physiological parameters (including the properties of collagen) have to be used to measure the rate of ageing and when this is done then no evidence has been found that radiation speeds up the normal rate of ageing. Another criterion for the rate of ageing is the time of onset of age-associated pathologies. Superficially, radiation may appear to bring these on earlier but careful studies, in which irradiated and unirradiated mice were killed at different times and their pathologies studied, showed that radiation did not speed up the various disease states uniformly. This is particularly apparent from studies of the incidence of neoplasia. If irradiation accelerated the processes that lead to ageing, then the latent period before pathological lesions (malignant or otherwise) should become detectable would be shortened in the irradiated group but the incidence (i.e., the fraction of all animals affected) would be the same as in the control. In experiments this was, in fact, the situation for lung tumors but the appearance of benign hepatomas was exactly the same in irradiated and unirradiated animals. A dose of 100 R of x rays more than doubles the normal rate at which spontaneous somatic mutations occur in mice. The radiation experiments, therefore, far from supporting the somatic mutation hypothesis can be interpreted as demonstrating the opposite, in the sense that exposure to x rays which result in a large increase in somatic mutations does not accelerate ageing. For the induction of tumors and leukemia by ionizing radiations, time-dose relations do not fit a mutagenic process and suggest that the cause is one of the many other biological changes which radiations bring about. After further examination of the hypothesis that somatic mutations constitute the subcellular lesions that result in ageing, in relation to the effects of ionizing radiations, it is concluded that somatic mutations do not play a major part in initiating ageing. (BBB)

38530 AUTONOMOUS PLEIOTROPY IN DROSOPHILA. Stern, Curt; Tokunaga, Chiyoko (Univ. of California, Berkeley). Proc. Nat. Acad. Sci. U. S., 60: 1252-9(Aug. 1968).

In Drosophila melanogaster the mutant split leads to abnormal differentiation of the compound eyes and of thoracic bristles. Homozygous spl/spl spots on females heterozygous for spl behave autonomously in development leading to spl eye areas if on the eyes, and to spl bristles if the spots occur on the thorax. The pleiotropy of spl is thus shown to be autonomous in nature. The results of similar studies with the mutant engrailed are compatible with, but do not establish, the presence of autonomous pleiotropy. (auth)

38531 ON THE CHROMOSOME BREAKS OF THE NEW ASCITES CARCINOMA AFTER X-RAY IRRADIATION. Yoshikubo, Kunihiko; Takahashi, Teiichiro (Jikei Univ., Tokyo). Nippon Kgaku Hoshasen Gakkai Zasshi, 28: 1487-96(Feb. 1969). (In Japanese).

There are five different strains of preserved ascites carcinoma of mouse in Japan. In these strains, four have transformed from spontaneous carcinoma to ascites carcinoma. Recently a new strain ascites carcinoma of the mouse was established which transformed from breast carcinoma on the Swiss Albino mouse/Jikei. The assets of the new ascites carcinoma are as follows: from past studies there was no technique for transforming ascites carcinoma from solid carcinoma, the history of the tumor was well known, this tumor was transformed from spontaneous carcinoma, the transplantability was excellent, the cells were in a free condition, the observation of chromosomes was easy and the chromosomes were ten in number. The experimental results are as follows. The transplantability was 100 percent, and the average number of lethal days after inoculation was 18 days. Metastases in liver and lung were observed histologically 14 days after inoculation in the abdominal cavity of the mouse. The modal chromosome number was 44 and contained an average of 14 percent of polyploid cells. The average mitotic rate was 5.6 percent. The chromosome breaks in 8 hours after x irradiation were about 5 percent with 250 R and about 10 percent with 500 R. (NSAJ)

38532 ENZYME ACTIVITY OF DONOR ORIGIN IN MOUSE RADIATION CHIMERAS. Hard, R. C. Jr.; Allen, R. C.; Moore, D. J.; Kullgren, B. (Medical Coll. of Virginia, Richmond. Armed Forces Inst. of Pathology, Washington, D. C. ORTEC, Inc., Oak Ridge, Tenn. Uppsala Univ.). Transplantation, 8: 9-18(July 1969).

Allogenic chimeras were formed by the injection of RF/A1(+) spleen cells carrying an enzyme marker (esterase-1) into lethally x-irradiated, esterase-deficient RF/A1(−) mice. Plasma samples and extracts of spleens, lymph nodes, and livers were electrophoresed on high resolution polyacrylamide gels and then scanned with a recording densitometer. Esterase zymograms show the presence of esterase-1 marker enzyme over long periods in the spleens and lymph nodes of all chimeras tested. Small quantities of the marker were found in 28% of chimeric plasma samples and 20% of the liver extracts. The results indicated continued production of the donor-specific enzyme in the host spleen and lymph node environments. The appearance of the esterase-1 in some plasma and liver samples may reflect genetic change of host cells. The results suggest that transplantation may be a worthwhile approach to the treatment of inborn errors of metabolism. The use of enzyme markers is proposed for further studies of such phenomena as graft adaptation, chimerism, and allogeneic cell interactions in vivo. (auth)

38533 LOCUS FOR RADIATION RESISTANCE IN ESCHERICHIA COLI STRAIN B/r. Donch, John; Chung, Young S.; Greenberg, Joseph (Medical Research Foundation, Palo Alto, Calif.). Genetics, 61: 363-70(Feb. 1969).

The gene responsible for uv resistance of strain B/r of Escherichia coli was investigated. A gene (lon) was cotransduced with proC from strain B/r to strain K-12 that produced a uv-sensitive, mucoid, filament-inducible phenotype. Ultraviolet resistance could not be cotransduced with proC (or lac or purE) from strain B/r to a K-12 lon strain. The gene for uv resistance in strain B/r is not an allele of lon but is located on the genome between lac and lon. (auth)

38534 EFFECTS OF X RAYS AND ETHYL METHANESULFONATE ON THE CHLOROPHYLL B LOCUS IN THE SOMA AND ON THE THIAMINE LOCI IN THE GERMLINE OF ARABIDOPSIS. Redei, G. P.; Li, S. L. (Univ. of Missouri, Columbia). Contract AT(11-1)-1609. Genetics, 61: 453-9(Feb. 1969).

The frequency of observable somatic alterations and germline mutations was studied at specific loci of Arabidopsis after treat-

ments with x rays and ethyl methanesulfonate (EMS). Identity of the somatic sectors was determined chromatographically. Mutants of the germline were identified by nutritional requirement (thiamine auxotrophy) and allelism tests. Under the experimental conditions, x rays induced more somatic alterations compared to the frequency of apparent point mutations. EMS and x rays induced approximately equal numbers of genetic changes in germline and soma. By phenotypic classification alone EMS appeared more effective than x rays in the induction of sectoring concerned with a specific locus. The chromatographic analysis revealed, however, that in the EMS series most of the visually classified ch sectors contained substantial amounts of chlorophyll-b, while in the x ray series the majority of the ch appearing sectors contained only chlorophyll-a. The experiments showed that phenotypic classification of body sectors is unreliable for testing genetic alterations at specific loci, but chemical tests as used in Arabidopsis give meaningful estimates. (auth)

38535 MUTAGENS WHICH CAUSE DELETIONS IN ESCHERICHIA COLI. Schwartz, Daniele O.; Beckwith, Jonathan R. (Harvard Medical School, Boston). Genetics, 61: 371-6(Feb. 1969).

Nitrous acid and uv light were found to be very effective in inducing deletion mutations in Escherichia coli. X rays did not appear to be as useful for this purpose. In the system studied, a substantial proportion of nitrous acid induced deletions appeared to be repeats of a single type. In addition, a majority of nitrous acid induced deletions were microdeletions. (auth)

38536 NUCLEAR FACTORS AND DIFFERENTIAL RADIOSENSITIVITY OF SECALE SPP. Upadhya, Mahesh D. (Univ. of Hawaii, Honolulu); Chopra, V. L. Indian J. Genet. Plant. Breed., 27: 56-9(Mar. 1967).

A comparison was made of the sensitivity to x rays of four species of Secale, namely S. cereale, vavilovii, silvestre, and anatolicum. They were also studied for their DNA content, nuclear volume, distribution of heterochromatin at the early prophase, total chromatin length at somatic metaphase, and degree of karyotype symmetry. The dry seeds were irradiated with 50-kV x rays at doses of 15, 20, and 25 kR. The seeds were germinated and height measured after 15 days of growth. For study of the effect on the chromosomes the seeds were irradiated with 11 kR. The percentages of the cells showing chromosome breaks at the metaphase and dicentric bridges and fragments at anaphase, as well as the mean number of breaks per cell, are given. S. anatolicum was found to be most radiosensitive, since even the lowest dose of 15 kR reduced the seedling height by about 67%, whereas the next higher dose of 20 kR completely killed the seeds. Similarly, at 11 kR the mean number of chromosome breaks per cell was 1.89, and 60.57% of the cells showed 1 or more chromosome breaks. In contrast, S. cereale was most resistant to x rays. Although the degree of chromosomal damage in S. cereale, silvestre, and vavilovii by 11 kR was of similar magnitude, the data on the seedling height showed differences. Height for S. cereale showed a maximum reduction of only about 13.0% at the highest dose of 25 kR, whereas S. silvestre and vavilovii showed more than 50.0%. No correlation could be found between nuclear factors studied and the degree of radiosensitivity. S. cereale and vavilovii carried terminal heterochromatin as knobs on the early prophase chromosomes, whereas S. silvestre and anatolicum lacked such heterochromatin on the prophase chromosomes. (BBB)

38537 THE EFFECTS OF OXYGEN AND NITROGEN POST-TREATMENTS ON THE MORTALITY OF DROSOPHILA EGGS IRRADIATED AS STAGE-7 OOCYTES. Sankaranarayanan, K. (State Univ. of Leiden. Inst. for Radiopathology and Radiation Protection, Leiden). Mutat. Res., 7: 357-68(May-June 1969).

The effects of oxygen and nitrogen post-treatments on x-radioinduced dominant lethality were studied in Stage 7 oocytes of Drosophila melanogaster. Irradiations were carried out under anoxia, in air or in an oxygen atmosphere. A wide range of exposures from 1000 R to 14,000 R was used, the actual range depending on the gaseous atmosphere in which the flies were irradiated. The results indicate that: the dose-response survival curves obtained with either post-treatment are predominantly two-target; and with oxygen post-treatment the egg-survival is consistently higher relative to that observed with nitrogen post-treatment. The latter observation is interpreted as indicating oxygen-mediated repair of radiation-induced dominant lethal damage in State 7 oocytes. From the available data the oxygen-enhancement-ratio (O.E.R.) for dominant lethal induction in this germ cell stage is estimated to be about 2.6. (auth)

38538 THE OCCURRENCE OF SUPPRESSORS IN CAFFEINE-RESISTANT MUTANTS FROM E. COLI K12. Delvaux, Anne-Marie (CNRS, Gif-sur-Yvette, France. Univ. Libre, Brussels); Devoret, Raymond. Mutat. Res., 7: 273-85(May-June 1969).

Mutants resistant to lethal concentrations of caffeine (Caf^R) were derived from Escherichia coli K12. Caffeine resistance conferred on the mutants enhanced by a factor of 1.1 to 2.2, the resistance spontaneously shown by the wild-type strain. Caffeine was not found to behave as a purine analog in the biosynthetic pathway of purines. Neither cross-resistance to other purine analogs nor excretion or requirement in purine bases was observed. Caffeine-resistant bacteria derived from uv repair deficient strains appeared to acquire an increased resistance to uv irradiation. Some of these mutants could partially repair the uv damage produced in the bacterial DNA whereas for phage DNA they were either fully or not at all able to perform host-cell reactivation of uv-irradiated phage λ. In some Caf^R mutants there was a correlation between acquisition of caffeine resistance and suppression. About 80% of Caf^R mutants derived from E. coli K12 substrain 112 – 12 carried the amber suppressor su-II$^+$. It is suggested that selection of Caf^R mutants might be a way of collecting bateria with suppressors. (auth)

38539 INDUCTION OF MUTATIONS IN SACCHAROMYCES CEREVISIAE BY ULTRAVIOLET LIGHT. Resnick, Michael A. (Univ. of California, Berkeley). Mutat. Res., 7: 315-32 (May-June 1969).

Mutation induction by ultraviolet light was examined in a uv-sensitive (uvs 9 – 3) and a wild-type (UVS) strain. Induced reversion to prototrophy in both strains occurred regardless of whether the original auxotrophic mutation arose by a base-pair substitution (missense or nonsense category) or by an addition–deletion event. In the UVS strain a significant amount of the uv-induced reversional lesions were caused by pyrimidine dimers, while in the sensitive strain pyrimidine dimer damage was only detected when reversion occurred by addition–deletion events. At equal doses, uv-induced reversion frequencies in the UVS strain were always less than in the uvs 9 – 3 strain. A comparison of dark repair and photoreactivation of lethal and mutational damage indicated that lethal lesions are generally repaired more readily than mutational lesions by dark repair. Similarly, photoreactivation removes lethal damage in the uvs strain more efficiently than mutational damage; however, in the wild-type strain both types of damage are removed with equal efficiency. Forward mutations induced at the tr 5 locus were classified according to ability to complement, suppressibility, and osmotic remediability. A mutant exhibiting any one of these characteristics was considered to have arisen by a base-pair substitution event. After uv 16 tr 5 mutants (among 42,233 colonies) were isolated in the uvs strain without photoreactivation, while none were isolated after photoreactivation (0/23,541 colonies). Twelve of the mutants were attributed to base-pair substitution events; thus, pyrimidine dimers were concluded to cause primarily base-pair substitution mutations at this locus. Since the mutation frequency at the tr 5 locus in the UVS strain was the same before and after photoreactivation, the lesions causing the mutations were considered to be those other than pyrimidine dimers. However, this damage also produced mainly base-pair substitution mutations (16/19). (auth)

38540 RADIOSENSITIVITY AND REPAIR TIME: THE REPAIR TIME OF CHROMOSOME BREAKS PRODUCED DURING THE DIFFERENT STAGES OF THE CELL CYCLE. Prempree, Thongbliew; Merz, Timothy (Johns Hopkins Univ., Baltimore). Mutat. Res., 7: 441-51(May-June 1969).

The repair times of x-radioinduced chromosomal breaks produced at different stages of the cell cycle were studied. Human peripheral lymphocyte cultures were used because of their relative synchronous character. The repair time in G_1 and S was observed to be 90 min. In late S and G_2 the repair time was 60 min. The 30-min decrease in repair time in G_2 was thought to be attributable to a change in the repair system itself rather than the cell's commitment to division. The possibility that repair efficiency may well be dictated by factors preceding the repair act is discussed. (auth)

38541 CHROMOSOME ABERRATIONS INDUCED IN HUMAN LYMPHOCYTES BY X-IRRADIATION IN VITRO: THE EFFECT OF CULTURE TECHNIQUES AND BLOOD DONORS ON ABERRATION YIELD. Sharpe, Heather B. A.; Scott, D.; Dolphin, G. W. (Medical Research Council, Harwell, Eng.). Mutat. Res., 7: 453-61(May-June 1969).

Quantitative relationships between chromosome aberration yields in peripheral blood lymphocytes following in vitro irradiation have been reported by a number of workers. A comparison of these data shows that considerable discrepancy exists between them, and the object of this paper is to investigate some possible causes of this discrepancy. The effects of various techniques of culture, fixation, and different donors on the aberration yield were tested. Results show that none of these variables had any significant effect on the aberration yield and consequently the cause of the discrepancy must be sought elsewhere. Scoring criteria may be important. (auth)

38542 EFFECT OF TRITIATED THYMIDINE ON SISTER-CHROMATID EXCHANGE IN A RING CHROMOSOME. Brewen, J. G.; Peacock, W. J. (Oak Ridge National Lab., Tenn. Commonwealth Scientific and Industrial Research Organization, Canberra, Australia). Mutat. Res., 7: 433-40(May-June 1969).

Peripheral lymphocytes from a human male heterozygous for a ring chromosome were cultured both in the presence and absence of tritiated thymidine. Analysis of colchicine-anaphase cells showed that incorporated tritiated thymidine induced a substantial increase in the frequency of dicentric ring chromosomes. Comparable levels of dicentrics in the first and second cell cycle following isotope incorporation indicated that dicentric induction is a dose (tritium)-independent process. The frequency of induced dicentrics, and hence of induced exchange between the sister ring chromatids, approximated the frequency of sister-chromatid exchange (determined autoradiographically) in rod chromosomes. This suggests, but does not prove, that sister-chromatid exchanges in rod chromosomes are radiation induced events. (auth)

38543 PARAMETERS OF SPONTANEOUS AND X-RAY-INDUCED REVERSION OF THE WHITE-IVORY MUTANT OF DROSOPHILA. Bowman, J. T. (Utah State Univ., Logan). Mutat. Res., 7: 409-15(May-June 1969).

The white-ivory mutant of Drosophila melanogaster reverts frequently to wild type both in germinal and somatic cells. Spontaneous germinal reversion is restricted to meiosis and is dependent on synapsis with a structurally normal homologue. Reversion in mitotic cells, both premeiotic germinal and somatic, shows no such restriction and is, furthermore, greatly enhanced by x irradiation. In somatic cells, the frequency of induced reversion is a linear function of the x-ray dose. The effectiveness of x rays is, however, much greater in somatic than in premeiotic germ cells. The properties of the white-ivory mutant suggest that it is the result of the addition of genetic material to the white locus although the nature of this addition remains an intriguing mystery. (auth)

38544 X-RAY-INDUCED RECESSIVE LETHALS IN NEWLY INSEMINATED EGGS OF DROSOPHILA MELANOGASTER. Graf, U.; Piatkowska, Barbara; Wuergler, F. E. (Swiss Federal Inst. of Tech., Zurich). Mutat. Res., 7: 385-92(May-June 1969).

In newly inseminated eggs of Drosophila melanogaster the paternal X-chromosome is more sensitive to the x-ray induction of recessive lethals than the maternal X-chromosome, which shows no change in sensitivity at any stage from anaphase of meiosis I until completion of meiosis. In contrast to this, the paternal X-chromosome in the sperm head that changes into the paternal pronucleus goes through a transient phase of very high sensitivity. (auth)

38545 LOCALIZATION OF ECERIFERUM LOCI IN BARLEY. Fester, Torsten; Soegard, Bodil (Univ. of Copenhagen). Hereditas, 61: 327-37(1969).

Forty-four different loci are known in barley which give rise to mutants of the eceriferum phenotype, a reduction or absence of wax coating. At these loci 380 mutants have been induced and since most of them are fully viable and easy to classify, they constitute useful chromosome markers and a basis for eventual understanding of the action of genes controlling epidermal wax deposition. Allelic relations of the mutants and the distribution of the loci among the 7 chromosomes were determined. The following radioinduced eceriferum mutants with a translocation linked to the cer locus were used: cer-a^{12}-T, cer-n^{39}-T, cer-i^{35}-T, and cer-d^{111}-T isolated from erectoides-a^{25} after treatment of resting seeds with 4500 rad of x rays. For linkage analysis, eceriferum mutants were induced by treatment of resting seeds with a neutron dose of 280 rad, or after irradiation of pollen with x rays (720 rad), after treatment of resting seeds with neutrons (200 rad) and after treatment of resting seeds with 0.03% ethyleneimine. The translocation tester sets consisted of strains isolated from ert-a^{25} after treatment of resting seeds with 250 rad of neutrons. In the eceriferum mutants induced by different mutagens (x-, γ-rays, neutrons, sulfonates, and ethyleneimine) it is possible that an inversion simultaneously induced in the mutant stock may mask the correct linkage values for some mutants. Thirteen of the 44 eceriferum loci identified in barley could be localized. Cer-g, cer-n, cer-s, and cer-zm are located in chromosome 2, cer-r and cer-zd in chromosome 3, cer-j in chromosome 4, cer-e in chromosome 5, and the 5 cer loci b, i, t, x, and zj were found in chromosome 7. The loci are distributed over 5 chromosomes, which is indicative of a random distribution in the linkage groups, as is found for erectoides loci. (BBB)

38546 THE EFFECTS OF GUANINE AND XANTHINE ON THE RADIOSENSITIVITY AND MUTABILITY OF BARLEY (HORDEUM VULGARE L. s. l.). Krausse, Guenter W. (Martin-Luther-Univ., Halle, Ger.). Abh. Deut. Akad. Wiss. Berlin, Kl. Med., 31-6(1967).

The effect on the irradiation-induced mutation frequency and on the physiological M_1 damage of various chemical compounds was examined in barley. The 2 purine bases guanine and xanthine were shown to be the most effective in their influence on x-ray-induced mutability. Seeds of the spring barley variety Plena were germinated for 62 hr in solutions of guanine and xanthine then x irradiated with doses of 0.4, 0.8, or 1.2 KR. In the M_1 generation, guanine increased the radiosensitivity of barley only slightly. Duration of the vegetative period was prolonged by 1 day and fertility was decreased when guanine was combined with high x-ray doses. Survival at maturity was slightly not significantly increased by additional treatment with xanthine. In contrast to guanine, xanthine did not intensify the effects of irradiation although fertility was decreased. Reduction of fertility was presumably due to an increased number of chromosome aberrations. The largest decrease of fertility was obtained by the smallest concentration used (0.01%) whereas a higher concentration (0.1%) showed less influence. Guanine and xanthine used alone were not mutagenic. In combination with x rays the 2 purines caused a considerable increase in irradiation-induced mutation frequency. In comparison with controls (treated by soaking in water and irradiation) guanine increased the frequency of chlorophyll mutations, with 0.4 KR from 4.6 to 7.5 and with 0.8 KR from 11.0 to 15.1%; these are increases of 64 and 37%, respectively. An additional treatment with xanthine increased the frequency of chlorophyll mutations with 0.4 KR from 4.6 to 5.5 and with 0.8 KR from 11.0 to 16.0%; these are increases of 20 and 45%. The mutation spectrum (chlorophyll as well as morphologic and physiologic mutations) was changed especially by the additional treatment with guanine in comparison with the controls. For all x-ray variants this treatment caused a decrease of albina as well as morphologic and physiologic mutations as opposed to other chlorophyll mutations. There was a close negative correlation between survival in M_1 and mutation frequency in M_2, i.e., low survival rate corresponded to high mutation frequency. This negative correlation was not abolished by additional treatment with guanine or xanthine, but the regression coefficient was increased. If survival was decreased by 10% from larger doses of irradiation, for example, mutation frequency was increased by irradiation alone by 2.5%, but in combination with the purine bases by 3.8%. (BBB)

38547 INFLUENCE OF OXYGEN LET ON RADIATION-INDUCED MUTATION IN HEXAPLOID WHEAT. Blixt, S. (Weibullsholm Plant Breeding Inst., Landskrona, Sweden); Dumanovic, J.; Ehrenberg, L.; Loefroth, G. Agri Hort. Genet., 26: 66-77(1968).

Seed of the Rival variety of spring wheat was irradiated with ^{60}Co γ rays in air at doses of 8, 12, 18, and 25 Krad, in N_2 with doses of 12, 18, 25, 36, and 50 Krad, and by slightly moderated fission neutrons in air at doses of 170, 250, 350, 500, and 650 rad. The water content of the seeds was 13.3%. At comparable lethal doses ($RBE_{n/\gamma\ air}$ = 40) the following efficiencies in inducing genetic effects were found. Neutrons induced X_1 speltoid chimeras in an almost linear dose dependence, whereas both γ-ray series exhibited the same, exponential dose-dependence with high proportions of chimeric plants reached around LD_{75}. Neutrons induced speltoid and other morphological mutants observable in X_2, in a linear dose response, whereas aerobic γ irradiation gave very low mutation rates, evidently ascribable to a marked elimination of mutations. This elimination was less pronounced for anaerobic γ irradiation, which was thus mutagenically more efficient (at low doses the efficiency was about the same as that with neutrons) than aerobic γ irradiation. It was concluded from the somatic radiation effects that lesions induced by neutrons and anaerobic γ radiation are mainly ascribable to genetic damage, in contrast to the effects of aerobic γ radiation. (BBB)

38548 ULTRAVIOLET INDUCTION OF CHROMOSOME TRANSFER BY AUTONOMOUS SEX FACTORS IN ESCHERICHIA COLI. Evenchik, Z. (Israeli Inst. for Biological Research, Ness-Ziona); Stacey, K. A.; Hayes, W. J. Gen. Microbiol., 56: 1-14(Apr. 1969).

Ultraviolet irradiation (2537 Å) of E. coli K 12 bacteria, carrying on autonomous F factor or an F-prime factor, enhanced the fertility of the population by increasing the number of cells which can transfer the bacterial chromosome. In contrast, under similar conditions the fertility of irradiated Hfr populations fell in proportion to the survivors. Following irradiation, the effect began to develop after about 30 min incubation in broth at 37°, reached a peak at about 90 min, and thereafter slowly declined. The effect developed with similar kinetics during postirradiation incubation in minimal medium as in broth. A comparison of the

kinetics of the effect with the growth of the population as a whole showed that the uv-induced donor state is not inheritable. Mitomycin C, which resembles uv radiation in producing DNA damage repairable by a mechanism involving excision of single-stranded fragments, also induced new donor bacteria. Other agents such as x rays and methyl methanesulfonate (MMS) did not stimulate the production of new donors but may have enhanced the recombination frequency. After x irradiation the relative decrease in the capacity for transfer of uv-induced donors was apparent only when the proportion of survivors exceeded about 25%. A possible mechanism for this phenomenon is suggested whereby the excision of single-stranded fragments of the bacterial chromosome, during the repair of uv damage, facilitates pairing with homologous regions of the complementary sex factor strand. A recombination event, mediated by breakage and covalent bonding, then joins a free end of the excised DNA strand to the paired sex factor strand. Thus, recombination connects sex factor and chromosome by only a single strand instead of by the 2 strands which normally leads to insertion and the formation of an Hfr chromosome. It is postulated that such a structure can be transferred at conjugation, but is incapable of more than one cycle of replication. (BBB)

38549 EFFECT OF EDTA ON THE REJOINING OF CHROMOSOME BREAKS INDUCED BY X RAYING. Irie, Hiroyuki (Hokkaido Univ., Sapporo). Bot Mag, (Tokyo), 82: No. 969, 97-101(Mar. 1969).

Two kinds of radioinduced chromosome breaks (rapidly and slowly rejoining breaks) can be distinguished on the basis of their average time of restitution. In order to investigate whether the rapidly rejoining breaks are of an ionic nature or not, the effects of EDTA on the rejoining of the x-radioinduced chromosome breaks were investigated with the root tips of Vicia faba. The results obtained showed that the pre-irradiation treatment with EDTA gave a significantly higher frequency of both chromatid exchanges and chromatid breaks than in the x-ray control, whereas the post-irradiation treatment with this chemical did not result in any increase in the frequency of aberration yield. These results indicate that EDTA affects mainly the rejoining process between the rapidly rejoining breaks and thus they are of an ionic nature. (NSA of Japan)

38550 MICROAUTORADIOGRAPHIC STUDIES OF THE INCORPORATION OF TRITIUM-LABELED URIDINE INTO THE GERM CELLS OF DROSOPHILA MELANOGASTER. Benes, Lumir; Winterfeld, Gisela; Delzer, Wilfried; Magdon, Erwin (Institut fuer Krebsforschung, Berlin). Strahlentherapie, 137: 742-8(June 1969). (In German).

The incorporation of tritium labeled 5-bromo-uracil-deoxyriboside was studied in the primordial germ cells in irradiated and control male Drosophila. When the labeled drug was administered immediately after the irradiation, an increase in the mean grain count per cell and of the labeling index was observed. The increase amounted up to 2.5 the value of the controls. When the nucleoside was given one half hour after irradiation, the mean grain count was the same, but the labeling index was even lower than in the controls. These results are discussed in relation to the mutagenic effect of BUdR when combined with irradiation. (auth)

38551 THE SIZE OF THE PHOTOSYNTHETIC UNIT AND ITS VARIABILITY. I. CALCULATION OF THE SIZE OF THE PHOTOSYNTHETIC UNIT. Wild, Aloysius; Egle, Karl (Univ., Frankfurt am Main). Beitr. Biol. Pflanz., 45: 213-41(1968). (In German).

A uv-radioinduced (254 nm required) mutant and a normal strain (C-1.1.10) of Chlorella pyrenoidosa were compared as to the size of the photosynthetic unit and its variability. The normal strain had the high photosynthetic efficiency of 180 μmole CO_2/hr mg chlorophyll with a content of about 30 mg chlorophyll a + b/g dry weight. A relation was established between this high efficiency and the size of the photosynthetic unit by means of the half-value period of the limiting reaction in the electron transport chain which was 10^{-2} sec. Under this assumption it was calculated that 1 reduced CO_2 molecule equals a photosynthetic unit of 2000 to 2400 molecules of chlorophyll in the normal green Chlorella. For the chlorophyll-deficient Chlorella uv-radioinduced mutant, 850 molecules of chlorophyll were calculated for 1 reduced CO_2. If it is assumed that 8 light quanta are necessary to reduce one CO_2, 250 to 300 molecules of chlorophyll were obtained for the normal strain and 100 molecules of chlorophyll for the mutant. In the normal green Chlorella cell there are about 1.5 million photosynthetic units consisting of 250 to 300 chlorophyll molecules. In comparison with the normal cell the pale green cell of the uv-radioinduced mutant has about 0.9 million units of ~100 molecules of chlorophyll. The ratio of the chlorophyll amount between the normal and the mutant form is 5.1:1, whereas the proportion of the photosynthetic units is 1.7:1. The normal strain shows light saturation at 4000 Lux (374 fc) while the mutant begins to saturate near 10,000 Lux (935 fc). This phenomenon is explained by the difference in the size of the photosynthetic unit. The Chlorella mutant yields a higher photosynthetic rate than the normal strain under unsaturated conditions of the light too. (BBB)

Health Physics and Safety

Refer also to abstract 38143.

38552 INTRODUCTION TO HEALTH PHYSICS. Cember, H. International Series of Monographs in Nuclear Energy, Vol. 105. Oxford, Pergamon Press, 1969. 422p. 100s.

The following topics are discussed: Physical principles; atomic and nuclear structure; radioactivity; interaction of radiation with matter; radiation dosimetry; biological effects of radiation; radiation protection guides; health physics instrumentation; external radiation protection; internal radiation protection; criticality; and evaluation of protective measures. (UK)

Radioactive Contamination and Decontamination

Refer also to abstracts 38377 and 38603.

38553 (COO-1171-103) FOOD CHAIN TRANSFER OF ^{137}Cs FROM TROPOSPHERE TO MAN. Ward, Gerald M.; Johnson, James E.; Wilson, Daniel W. (Colorado State Univ., Fort Collins. Dept. of Animal Science). Apr. 15, 1969. Contract AT-(11-1)-1171. 21p. Dep. CFSTI.

Results to date are presented from a series of investigations to determine the transfer of ^{137}Cs through food chains from the troposphere to man. Four separate lines of investigation were conducted. Results of current studies to predict the fallout rate and crop contamination by surface air levels strongly suggest that dry fallout was the primary means of contamination of fallout ^{137}Cs in forages in the study area. A simplified model to predict milk concentrations of fallout ^{137}Cs from surface air concentrations was developed. Investigation of the importance of soil concentrations of fallout ^{137}Cs revealed that, owing to the high percentages of clay minerals in the local soils, direct foliar fallout deposition was more important than direct soil uptake by forages and grains which was negligible. In an investigation of the transfer of fallout ^{137}Cs from forages and grains to milk and meat, it was found that forages are the prime source of uptake of ^{137}Cs in dairy and beef cattle. The transfer of fallout ^{137}Cs from feed to milk and meat was described by parameters termed milk transfer coefficient and meat transfer coefficient respectively. The importance of meat and milk and other dietary constituents on the transfer of fallout ^{137}Cs to man was also investigated. Measurements were made of the ^{137}Cs intake of several families from all dietary sources and body burdens were measured monthly. Knowledge of the rate of change of intake made it possible to calculate the retention half-times for each individual. Knowing this parameter aids in the prediction of human doses. A brief discussion is included of all experimental work carried out during 1968 to 1969. (E.R.B.)

38554 (SWRHL-26r) RADIOIODINE STUDIES FOLLOWING THE TRANSIENT NUCLEAR TEST (TNT) OF A KIWI REACTOR. Black, S. C.; Barth, D. S.; Engel, R. E.; Falter, K. H. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab. Bureau of Radiological Health, Rockville, Md.). May 1969. 92p. Dep. CFSTI.

In conjunction with the Transient Nuclear Test of a Kiwi reactor, on January 12, 1965, hay contamination and controlled dairy cow ingestion studies for radioiodines were conducted. The studies were designed to simulate the maximum possible radioiodine uptake by dairy cows under winter dairy farming conditions, where radioiodines enter the cows via ingested, contaminated hay. The kinetics of the secretion of radioiodines in milk under the conditions of this experiment were determined. Peak values of 830 pCi/liter for ^{133}I and 150 pCi/liter for ^{131}I were observed in the milk of individual cows. For ^{131}I the effective half-life in the milk of Group I cows was found to be 5.7 days, whereas for Group II it was 2.9 days. Air sampling results indicated that the contaminant ingested by Group I cows was less gaseous in nature than was the contaminant for Group II cows. (auth)

38555 (SWRHL-53r) SPECIAL BOVINE SAMPLING STUDY: PROJECT ROLLERCOASTER SITES. Brechbill, Raymond A. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). June 1969. 23p. Dep. CFSTI.

Six bovine, three young animals and three aged animals, that were grazing on or near the 1963 Project Rollercoaster sites were sacrificed in April 1967 to assess the body burden of ^{239}Pu in these

animals. Levels found in various tissues were higher than those found in bovine grazing on the NTS but far below the MPC levels established for humans. The maximum dose an individual could receive from consuming tissue from these animals is negligible. No pathology was found on either gross or microscopic examination that could be directly related to radiation. Due to the obscure etiology of the described lesions, it would be impossible to reach any definite conclusions as to their origin; but it would appear to be due to some other cause than radiation, since the body burden of ^{239}Pu was well below those levels known to induce detectable radiation damage. No statistical difference was found in the levels of ^{239}Pu between the young and aged animals. Hilaria jamesii constituted 86% of the animals' diet. (auth)

38556 DEVICE FOR THE DECONTAMINATION OF IRRADIATED ARTICLES. Egoroff, Nicolas. French Patent 1,475,093. Filed Mar. 16, 1966.

A device for the decontamination of irradiated articles is described that comprises a tank of stainless steel, partly filled with a suitable solvent, preferably methanol, and provided with a cover permitting the tank to be hermetically closed, means for suspending the articles to be decontaminated in the space above the solvent, means for cooling said articles, and means for heating the solvent. In use the vapor produced by the heating of the solvent condenses on the surface of the cooled article and the liquid falls back in drops into the layer of the solvent thereby entraining the radioactive particles adhering to the articles. (NPO)

38557 CONTAMINATION OF FOODS BY RADIOACTIVE ISOTOPES. Sasaki, Rikiko. J. Starch Technol. Res. Soc. Japan, No. 35, 35-41(Aug. 1967). (In Japanese).

Radioactive fallout caused by nuclear explosions contaminate cereals, vegetables, root crops, and other crops. Among such radioactive isotopes, ^{90}Sr has a large influence on the health of man. The content of ^{90}Sr in Japanese daily diets in urban and rural districts of nine prefectures was measured between June 1962 and March 1963. The ^{90}Sr content was, in general, higher in June and July than in October and November, and it was higher in the region adjacent to the Japan Sea than that adjacent to the Pacific Ocean. The highest was in the urban adult diet of Akita Prefecture in October (22.7 pCi), but this degree of contamination was not considered to be dangerous. The content of ^{90}Sr in soybeans harvested in autumn 1963, collected from the whole country, was measured. The ^{90}Sr content was higher in the region adjacent to the Japan Sea than that adjacent to the Pacific Ocean, as in the case of daily diets. The content in the central area of Japan, such as Yamanashi and Gunma Prefectures, was intermediate between the two sides. The content of ^{90}Sr in foreign soybeans and their products was less than in crops from Japan. In the decontamination of vegetables washing decreased the ^{90}Sr content in lettuce about 60% and 26.5% in cabbage when a 0.25% solution of acetic acid was used, and 64.7% in cucumbers and 23.8% in eggplant when a 0.1% solution of NaCl was used. The ^{90}Sr content in the body was higher in primary and high school children than in adult women. (NSA of Japan)

38558 ENVIRONMENTAL RADIATION STUDIES AND PRECAUTIONARY MEASURES ON THE HIGH ALTITUDE COSMIC RAYS, FISSION PRODUCTS FROM NUCLEAR DETONATION AND AIRCRAFT EQUIPMENT. I. STUDIES ON THE RADIOACTIVE CONTAMINATION OF JET AIRCRAFT, JET PILOTS, MAINTENANCE PEOPLE AND ON THE INTERNAL RADIATION EXPOSURE OF JET PILOTS DUE TO FLYING OVER JAPAN AFTER RED CHINA NUCLEAR DETONATION FROM 1965 TO 1967. Naba, Katsumi (Keio Univ., Tokyo). Keio Igaku, 45: 513-20(Nov. 1968). (In Japanese).

Immediately after the nuclear detonations that occurred during 1964 to 1967, the atmosphere over Japan was highly contaminated with fission products. In this contaminated atmosphere, jet aircraft flew as usual. As a result, surface and internal radioactive contamination of humans and aircraft occurred. The surface contamination of jet aircraft and the skin, nostrils, and gloves contamination of pilots and maintenance people were monitored using a GM survey meter and autoradiographical methods. The survey was conducted from the 3rd Red China nuclear detonation to the 5th. The results of this survey were as follows: maximum aircraft contamination was $2.4 \times 10^{-3} \mu Ci/cm^2$ on the wing; maximum jet pilot contamination was 0.4 μCi on the right sleeve of flight suits and 3.1×10^{-2} μCi on the right glove; maximum maintenance people contamination was 7.2×10^{-2} μCi on the glove. The internal radiation exposure of jet pilots was determined by urinalysis for ^{90}Sr using the ion resin exchange-EDTA method; measurement of radioactivity by low background 2π gas flow counter was employed. The results of the urinalyses for military jet pilots from Dec, 1964 to May, 1966 were as follows: maximum urinary ^{90}Sr and ^{89}Sr excretion levels were 20 pCi/L urine, minimum level was 0.7 pCi/L urine, and the average level was 4.7 pCi/L urine. Estimation of ^{90}Sr body burden in jet pilots, calculating from urinary excretion level 4.7 pCi/L were equivalent to a 0.17 μCi body burden. Comparing the contribution of surface contamination with the accumulation of body burden, the surface contamination was as important a contribution as inhalation. (NSA of Japan) (TSS)

38559 ^{222}Rn DAUGHTER CONCENTRATIONS IN URANIUM MINE ATMOSPHERES. Blanchard, R. L. (Bureau of Radiological Health, Cincinnati). Nature (London), 223: 287-9 (July 19, 1969).

A study is described which was undertaken to measure the concentrations of ^{210}Pb and ^{210}Po in uranium mine atmospheres at various radon daughter concentration levels, and to determine the amount of ^{210}Pb in the mine atmosphere relative to that produced from the decay of the short-lived radon daughters deposited in the lungs. Measurements were also made of the amount of ^{210}Pb which may be associated with ^{226}Ra in airborne ore dust. The uranium mines investigated were in the Ambrosia Lake area near Grants, New Mexico. The analytical procedure adopted is described, and results are tabulated. The exposures which the airborne concentration of radon daughters will deliver are given. The quantities of ^{210}Pb produced in the lung by the complete decay of inhaled short-lived ^{222}Rn daughters were less than those present in the mine atmosphere, and for most samples the atmospheric ^{210}Pb was much higher, ratios varying from 1.7 to 27, with an average value of 4.7 ± 2.9. The average ratio of measured ^{210}Pb in bone to that attributed to inhaled short-lived radon daughters was 2.7 ± 1.0, from which it is clear that the excess ^{210}Pb in the bone of a uranium miner may be attributed to airborne ^{210}Pb in the mines. The percentage of ^{210}Pb associated with ^{226}Ra in the airborne dust varied from <1% for samples of higher ^{210}Pb concentration to 77% for those of lower concentration, with an average of 22%. The chief fractions of ^{210}Pb atoms in these mines must therefore have been formed in the atmosphere by decay of short-lived ^{222}Rn daughters and were present either as free atoms or more probably as atoms attached to submicron dust particles. The times necessary to produce the observed airborne ^{210}Pb atoms, less those associated with ^{226}Ra, were calculated. The observations suggest that the amount of inhaled ^{210}Pb in the body will usually exceed that derived from inhaled short-lived radon daughters alone, and that this excess will depend on the rate of air turnover. From the results of these studies the excess ^{210}Pb which has been observed in bone can be explained. (UK)

38560 HYGIENIC EVALUATION IN CASES OF INHALATION OF RADIOACTIVE NUCLIDES MIXTURE IN FORM OF INSOLUBLE COMPOUNDS. Mueller, Jan; Malatova, Irena; Houskova, Marie; Furgyik, Stefan. Prac. Lek., 21: 185-90(June 1969). (In Czech).

During cyclotron maintenance work, one of the personnel became internally contaminated by inhalation of an unknown mixture of radionuclides. Components of the mixture were identified by radiochemical and γ spectrometric analysis. The retention function $r[t] = 0.5\ t^{-0.12}[t \geq 1]$ for the mixture of the insoluble compounds of ^{182}Ta and ^{65}Zn was calculated from the whole-body counter measurements covering 310 days. As this retention function is dependent on the effective cross-section of inhaled particles and their solubility, generalization is not possible. It was possible, however, to apply it for a group of another 15 maintenance workers, who did similar work and were also contaminated. Thus, the lung deposit could be calculated to the time of inhalation assuming that the mixture of radionuclides in the lung is distributed homogeneously. Since the internal contamination was found in the whole group of workers, it is obvious that the protection for the respiratory system used up to now, i.e., respirator with a filter, is not sufficient. (auth)

38561 EVALUATION OF ATMOSPHERIC RADON IN THE VICINITY OF URANIUM MILL TAILINGS. Shearer, S. D. Jr. (Southwestern Radiological Health Lab., Las Vegas, Nev.); Sill, C. W. Health Phys., 17: 77-88(July 1969).

A field study is currently being concluded at Grand Junction and Durango, Colorado, and at Monticello and Salt Lake City, Utah, to evaluate the public health aspects of atmospheric ^{222}Rn in the vicinity of uranium tailings piles. Air is collected continuously for 48 hr periods from each station in order to average out diurnal fluctuations and the integrated sample is then analyzed for ^{222}Rn. A total of 57 stations is in operation. Each station is re-sampled every three weeks for one calendar year to include seasonal fluctuations and to permit a more realistic estimate of the yearly dose to people in the immediate vicinity. Data and conclusions from the 1 yr study are presented. Of the 13 stations directly over tailings average radon concentrations ranged from 3.5 to 16 pCi/l. Of the 44 stations not over tailings only two averaged greater than 1 pCi/l. The results indicate negligible radiation exposure of the surrounding population from this source. (auth)

38562 EXTERNAL AND INTERNAL IRRADIATION OF SWEDISH REINDEER BREEDERS 1950–1970. Gustafsson, Monica (Univ. of Lund, Sweden). Health Phys., 17: 19–34 (July 1969).

The ^{137}Cs body burden of Swedish reindeer-breeding Lapps, which was at a maximum in early summer, 1965, was studied since 1961. Investigation of the seasonal variation in 1965 and 1966 shows that the annual ^{137}Cs dose to Lapps can be estimated by only one observation a year of the body burden. In June 1967, a survey was made in two Lapp communities with a portable sensitive γ-radiation dosimeter. In addition to indoor and outdoor measurements, the shielding effect of the snow cover was also studied. The total external natural irradiation amounted to 67 mRad/yr; the external irradiation from fallout during the period 1950 to 1970 is calculated to be about 55 mRad, an average increase of 4% over the natural external irradiation. The ^{55}Fe body burden of Swedish Lapps was estimated by analyses of blood samples. The dose from other natural and artificial radioactivity, especially ^{40}K, ^{210}Po and ^{90}Sr, was also calculated. The RBE of ^{210}Po α-particles is discussed. The average absorbed dose in the body from natural irradiation amounted to 95 mRad/yr. The irradiation from fallout, dominated by the contribution of 700 mRad from ^{137}Cs, reached 760 mRad during the twenty-year period. Comparisons are made with other Swedes and with other Arctic groups with similar food habits. (auth) (UK)

38563 CORRELATION BETWEEN INGESTION, ACCUMULATION, AND EXCRETION OF FALLOUT ^{90}Sr IN MAN ON A LONG-TERM SCALE. Fujita, M.; Iwamoto, J.; Kondo, M.; Yabe, A.; Akaishi, J. (Japan Atomic Energy Research Inst., Tokai). Health Phys., 17: 41–50(July 1969).

Determination was made of the levels of fallout ^{90}Sr in the diets and excreta from several volunteers from 1962 to 1967 in Tokai. Estimation of the total body burden of ^{90}Sr was carried out by a applying to the dietary intake a body retention formula for a single dose. Assessment of the body burden from urinalysis is discussed for chronic exposure. It is suggested that fecal level can be used as a substitute for dietary level approximately. (auth) (UK)

38564 DECONTAMINATION OF LEAFY VEGETABLES (LETTUCE, CABBAGE, SPINACH) CONTAMINATED WITH ^{137}Cs AND ^{85}Sr. II. EFFECTS OF ADDITIVES AND COMBINED TREATMENTS. Paulus, K. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Z. Lebensm.-Untersuch. Forsch., 139: 7–12(1968). (In German).

Effects of addition of various chemicals on removal of ^{137}Cs and ^{85}Sr from cabbage, lettuce, and spinach were studied. There were no effects observed when NaCl or KCl were added to batches treated at elevated temperatures or for extended cleaning times. Organic acids varied in their decontamination effects. Oxalic acid was more effective than citric acid, which was used at concentrations of from 0.1 to 0.2%. A combination of a short treatment at 90° followed by a rinsing at 20° was as effective as a long treatment at high temperatures. Rising times of 1 hr were adequate, and prevented damage to the vegetables. Citric acid had the same effect whether it was added during the washing or rinsing procedure. Treatment with 0.2% citric acid gave as good results as when the combined washing and rinsing procedure was used. (BBB)

38565 ELIMINATION OF ^{137}Cs FROM RATS TREATED WITH COLLOIDAL PRUSSIAN BLUE. Mueller, Wilhelm H. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Strahlentherapie, 137: 705–7(June 1969). (In French).

Different prussian blues with a lower, equal and higher biological efficiency than the one applied by Nigrovic were synthetized and tested on the rat. Soluble colloidal prussian blue showed the strongest ^{137}Cs decontamination effect. A relation exists between the biological effect and the thermodynamic stability of the Cs-ferri-ferro-cyanide system. After feeding with soluble colloidal and in the complexed part ^{59}Fe labelled prussian blue, a separation of the toxic CN ion was not recognizable. Parenterally applied colloidal soluble prussian blue underwent a destruction by the reticuloendothelial system. (auth)

38566 INTERNAL CONTAMINATION WITH TRITIUM. Minder, Walter (Eidgenoessisches Gesundheitsamtes, Bern). Strahlentherapie, 137: 700–4(June 1969). (In German).

Repeated and long lasting inhalation of high concentrations of tritium gas in air led to very serious contamination effects with fatal consequences in one case. Controls of tritium content in urine during 16 months after stopping work with radioactive material showed at least two different elimination velocities, one corresponding to biological half life of more than four months, the other of the order of magnitude of weeks. Definite figures were rather strongly influenced by the mode of calculation. Resulting values range between 10.5 and about 30 days for the short and between 139 and about 230 days for the long half life. Tritium concentrations in pathological preparations of muscles, kidney, liver, spleen and lungs were about ten times higher than in the last excretions. In all investigated organs tritium was bound in a form completely insoluble in water. (auth)

Dosimetry and Monitoring

Refer also to abstracts 38110, 38191, 38241, 38248, 38254, 38258, 38273, 38291, 38333, 38336, 38377, 38423, 38425, 38427, 38476, 38558, 38655, 38657, 38660, 38663, 38664, 38698, 38721, 38799, and 39528.

38567 (AD–677370) HEALTH PHYSICS–PROCESS CONTROL REFERENCE MANUAL. VOLUME II. Van Den Berg, Alan J. (Army Engineer Reactors Group, Fort Belvoir, Va. Engineering Dept.). July 1, 1966. 306p. CFSTI.

The manual is designed for use by Nuclear Power Plant Process Control Specialists. It contains health physics and water chemistry procedures for guidance in plant operation. Although this manual cannot give detailed recommendations, necessary and sufficient for all conditions, it gives general recommendations suitable for typical plant use. Volume II contains sections on radioactive waste management, radiological monitoring, and health physics and radiochemistry instrumentation. (TAB)

38568 (AD–686511) APPLICATION OF GAMMA-RAY DIFFUSION THEORY TO RADIATION DOSIMETRY. Final Report. Ellett, W. H. (Neuro-Research Foundation, Inc., Brookline, Mass.). Mar. 1, 1969. Contract N00014-67-C-0247. 268p. (RR–69-1). CFSTI.
Thesis.

The diffusion equation governing γ-ray transport was evaluated by means of random sampling and records of photon trajectories in tissue-like materials obtained for photon sources ranging in energy from 20 to 2750 KeV. The records of photon interactions were analyzed to obtain three kinds of information relevant to the dosimetry of γ-ray sources within the mammalian body: the average dose to a volume that contains radioactivity, the dose as a function of distance from a point source of activity in both bounded and unbounded absorbers, and the energy and angular distributions of the scattered photon fluence. These results were compared with other exact scattering calculations, traditional methods of calculating the γ-ray dose, and experimentally determined point source functions. (auth) (TAB)

38569 (ORNL–TM–2657) THIRD QUARTERLY PROGRESS REPORT ON THE THEORETICAL SAFETY EVALUATION OF CONSUMER PRODUCTS FROM PROJECT GASBUGGY. Jacobs, D. G.; Rohwer, P. S.; Cowser, K. E. (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 11p. Dep. CFSTI.

Dose equivalent calculations for the hypothetical use of gas from the Gasbuggy well within the San Juan Basin were extended to include a source term with continuously decreasing concentrations of radionuclides. As a result of gas withdrawal from the cavity, most of the hypothetical dose would be associated with the use of gas during the first year of production. (auth)

38570 LEVELS OF SUPERFICIAL IRRADIATION OF PERSONNEL WORKING WITH DIFFERENT RADIATION SOURCES. Lyarskii, P. P.; Korenkov, I. P.; Moiseitsev, P. I. At. Energ. (USSR), 25: 463–5(1968). (In Russian).

Here are presented the levels of irradiation of the engineers and technicians, medical and auxiliary staff working with ionizing radiation in industry, scientific investigations and medicine, including nuclear reactors, charged particle accelerators powerful γ plants, radioisotope devices and apparatuses used for control and regulation of flow processes. (auth)

38571 CALCULATION OF THE INTEGRAL DOSE IN PATIENTS WITH CERVICAL CANCER. Szymczyk, Wislawa; Siuda, Jerzy; Baj, Mieczyslaw (Instytut Onkologii, Krakow). Pol. Tyg. Lek., 22: 1666–9(Oct. 23, 1967). (In Polish).

Two methods of calculation of the integral dose in individual cases receiving internal radium therapy are presented. The first method, based on complicated mathematical theory, proved too cumbersome in practical tests due to irregular contours of human body, nonuniform positioning and distribution of therapeutic doses, and also because of difficulties in keeping a patient in the same position while protracted measurements were made; thus, this method was not considered error-proof. The second method included some features of the first method, but essentially the calculation was made according to measurements based on three plaster anatomical models of women: normal, obese, and slim. Special calculations were prepared for individually irregular

types of female figures. The integral dosage was established as a function of the height and weight of the body. Thus, the integral dose decreased with the increased height of a figure and at a fixed mass; on the other hand, the dose increased with increased mass and at a fixed height, which provided a dose normalized to the same constant ionization value for a cervical carcinoma patient, with a possible 5% calculation error. (BBB)

38572 INFLUENCE OF BONE TISSUE UPON DOSE DISTRIBUTION IN HIGH-ENERGY ELECTRON BEAM THERAPY. Hattori, Hiroyuki (Aichi Cancer Center Research Inst., Nagoya, Japan); Kitabatake, Takashi. Tohoku J. Exp. Med., 95: 351-8 (Aug. 1968).

For precise planning in electron beam radiotherapy, the difference of electron absorption by different tissues of human body must be known. Electron absorption by the bone tissue may be different from that of other soft tissues, since the bone density is higher. Absorption of high-energy electron beams by fresh human bones was studied. The influence of bone tissue on the homogeneity of dose distribution was evaluated by the absorption equivalent thickness of the bone against water. Bone specimens were obtained from the pelvis, sternum, and ribs of four autopsy cases 50 to 60 yr of age. The energy dependency of absorption difference between the bone and water was practically negligible for the range of 16 to 31 MeV. The absorption equivalent thickness values were measured using 25 MeV electrons. The mean absorption equivalent thickness for nine specimens, of which the mean density was 1.18 g/cm^3, was 1.14. Therefore, the influence of bone absorption on dose distribution is regarded as practically insignificant in the electron beam radiotherapy of the chest wall or the pelvic region of cancer patients. (BBB)

38573 PANORAMIC RADIOGRAPHY. Phillips, James E. (Univ. of Pennsylvania, Philadelphia). Dent. Clin. N. Amer., 561-70 (Nov. 1968).

The radiation dose received by the oral tissues and gonads of the dental patient is compared for conventional radiography and for the three types of panoramic radiographic units in general use. Exposure of the nape of the neck is greater with the Orthopantomograph and Panorex examinations than it is with conventional intraoral procedures. With the Panoramix, the palatal tissues and the tongue receive the highest exposure. Exposure of nearly all other areas of the face and head, however, is markedly lower with panoramic procedures. The relatively long exposure times required for Orthopantomograph (12 sec) and Panorex (20 sec) examinations have led some dentists to believe that the exposure of the patient must be greater than in conventional intraoral examination. This is not true. The integral absorbed dose was found to be 700 g rad for the conventional technique when a fast film was used. Examination with the Orthopantomograph delivers 110 g rad to the patient, whereas 19 g rad is administered during examination with the Panoramix when intensifying screens and an exposure time of 0.06 sec are used. The use of no-screen film for the Panoramix examination, which is preferred by some operators because of the better detail it provides, would make the integral absorbed dose equivalent to that for the Orthopantomograph. The gonadal exposure during an Orthopantomographic examination is of the order of 0.1 mR. This would be equivalent to about 8 hr of exposure from neutral background sources. It is concluded that the exposure of the patient is less for a panoramic examination than for a conventional full-mouth examination in which a fast film is used, and it is certainly well within acceptable limits. (BBB)

38574 KERMA VERSUS FIRST COLLISION DOSE: THE OTHER SIDE OF THE CONTROVERSY. Auxier, J. A. (Oak Ridge National Lab., Tenn.). Health Phys., 17: 342-3(Aug. 1969).

Reference is made to ICRU Report 10A (Nov. 1962) and 11 (Sept. 1968) and to comments by several authors with regard to the complete adoption of its recommendations. Some of these authors have deprecated use of the term first collision dose and emphasized the advantages of kerma. The present author discusses this problem, and states that the confusion is now greater than it was before the introduction of the quantity kerma simply because of the imprecision introduced by the substitution of one precisely defined quantity as a substitute for two or three sometimes ill-defined quantities. In the meantime workers on dosimetry will continue to define a quantity which will correspond to that energy absorbed in a material, isolated in air or vacuum, and having dimensions such that equilibrium of primary and secondary radiations exists with negligible attenuation of the primary beam. This quantity is not kerma, but is the one quantity associated with the radiation field which most closely characterises that field by a single number. (UK)

38575 RBE, LET, z, v: SOME FURTHER THOUGHTS. Turner, J. E. (Oak Ridge National Lab., Tenn.); Hollister, H. Health Phys., 17: 356(Aug. 1969).

Reference is made to the author's previous papers on general concepts in radiation dosimetry (Health Phys. 8: 523(1962), 11: 1163(1965), 12: 949(1966), and Nature 208: 36(1965)), and some of the implications are further pursued, particularly with regard to LET values. Among other considerations it is pointed out that particles having the same LET do not, in principle, have the same RBE. It is also suggested that LET may be the wrong quantity for the interpretation of radiobiological studies; the right quantity may be suggested by quantum mechanics. It would appear, in principle, that RBE should be interpreted in terms of ion charge and velocity, rather than LET. (UK)

38576 DOSIMETRY OF SCATTERED RADIATION TO THE FETUS. Covington, E. Eugene; Baker, Alan S. (Memorial Hospital, New York). J. Amer. Med. Ass., 209: 414-15 (July 21, 1969).

Measurement of scattered radiation to the fetus during radiation therapy for Hodgkin's disease of the mediastinum was 0.0026 rads per rad given to the tumor, or 7.9 rads for 14 treatments or 3,500 rads. Measurements of scattered radiation made on a phantom for three different modalities indicate the scattered dose to a fetus would be 3.5 to 14 rads in early pregnancy, 31 to 49 rads in mid-pregnancy, and 129 to 248 rads in late pregnancy, for 14 treatments or 3,500 rads. (auth)

38577 CALCULATION OF THE DOSE FIELD OF A THIN ELECTRON BEAM. Narkevich, B. Ya.; Endovitskii, V. S.; Konstantinov, I. E. At. Energ. (USSR), 26: 473-4(May 1969). (In Russian).

The flux density of a point source, placed in an infinite homogeneous medium, emitting radiation in a single direction, was calculated, condensing the distance from the source and the angle with respect to the direction of the beam. The problem involved solution of the fundamental electron transfer equation. Using the coefficients reported by L. Spencer, a system of moments was calculated for 10 electron energy values ranging from 25 keV to 10 MeV. The data were tabulated, presenting the function of dose distribution of 1 MeV electrons in the tissue or tissue-equivalent material. (TTT)

38578 DIGITAL COMPUTATION IN RADIOTHERAPY. ANALYSIS OF TECHNIQUES FOR TELE-RADIATION OF THE BLADDER. da Rocha, Antonio Fernando Goncalves; Franca, Gilberto Paes (School of Medicine and Surgery, Rio de Janeiro, Pontifical Catholic Univ., Rio de Janeiro). Strahlentherapie, 137: 412-19(Apr. 1969).

Isodose distributions for different treatment methods in therapy of urinary bladder tumors, calculated by a digital computer, are presented. (auth)

38579 COMPARISON OF ^{60}Co GAMMA DOSIMETRY IN CALORIMETER AND IONIZATION CHAMBER. Nagl, Johann; Sanielevici, Alexandre (International Atomic Energy Agency, Vienna). Strahlentherapie, 137: 424-8(Apr. 1969). (In German).

The results from measurements with a graphite calorimeter and an ionization chamber show that variations in the ratio exposure absorbed dose occur in beams of different teletherapy units. The absorption curves in material were determined with identical instruments in ^{60}Co beams from teletherapy units of different construction. A possible explanation is the dependence of the ionization chamber reading from the unknown energy spectrum in graphite. This could differ from unit to unit, depending on the spectral composition of the radiation incident on the surface of the phantom. (auth)

38580 AVERAGE EXPOSURE DOSES TO THE RADIOLOGIST IN LOWER-EXTREMITY VENOGRAPHY. Perttala, Yrjoe; Rytilae, Aaro (Univ. Central Hospital, Helsinki). Strahlentherapie, 136: 566-8(Nov. 1968).

Measurements were made of the average exposure doses to the operator in 100 lower-extremity venographies. These measurements were effected by fluoro-glasses at 13 different points of the body. The maximum doses were measured on the forehead, the forearms, and the shoulders. The doses of radiation accumulated in the forehead in a single venographic examination were about 10 mR, in the left shoulder region 9 mR, and left forearm 15 mR. From the aspect of radiological protection, the doses were rather large; this was attributed to the radiation from the upper tube while the physician performed the injection. (auth)

38581 A METHOD FOR THE ANALYSIS OF ^{210}Pb IN THE URINE OF URANIUM MINERS. Cohen, Norman; Kneip, Theo. J. (New York University Medical Center, N. Y.). Health Phys., 17: 125-30(July 1969).

A method was developed which permits the rapid determination of ^{210}Pb in urine samples. Lead-210 content is determined by beta counting its daughter, ^{210}Bi, which is spontaneously deposited di-

rectly out of 500 ml of urine onto a stainless steel planchet. A plating time of three hours is necessary to achieve a recovery of 80 ± 5% of the ^{210}Bi present. The Minimum Significant Measurable Activity at the 95% confidence level is 0.6 pCi/l, for a counting time of 200 min. Creatinine content is determined for all samples as an estimate of the total collection time. Comparison of the estimated cumulative exposure with the ^{210}Pb content in the urines of 34 uranium miners indicated a significant positive correlation for those individuals who have not been engaged in mining operations for the past 3 to 10 yr. Further data are necessary to establish a definite relationship between ^{210}Pb output and working level months. (auth) (UK)

38582 DEPOSITION OF RADON DAUGHTERS IN HUMANS EXPOSED TO URANIUM MINE ATMOSPHERES. George, A.; Breslin, A. J. (Atomic Energy Commission, New York). Health Phys., 17: 115-24(July 1969).

Uranium mine and laboratory experiments are described for the determination of total respiratory deposition of radon daughters, together with the effect of particle size, tidal volume, respiratory frequency, nasal deposition, and growth of radon daughter particle size. Total respiratory deposition of radon daughters measured in humans exposed in uranium mines was found to range from 23 to 45%. From the mine and laboratory experiments both particle size and tidal volume were found to influence deposition, fractional deposition increasing with decreasing particle size and increasing tidal volume. Particle size differed with location within a mine. No dependence of deposition on respiratory frequency or minute volume was discerned. In laboratory experiments nasal deposition of attached and unattached radon daughters was found to be 2 and 62%, respectively, and evidence was developed indicating the rapid growth of radon daughter particles in the respiratory tract. (auth) (UK)

38583 ABSORBED FRACTIONS, SPECIFIC ABSORBED FRACTIONS, AND DOSE BUILD-UP FACTORS FOR DOSIMETRY OF INTERNAL PHOTON EMITTERS. Reddy, A. R.; Ayyangar, K.; Brownell, G. L. (Massachusetts General Hospital, Boston). Health Phys., 17: 295-304(Aug. 1969).

An improved method for determining absorbed dose from internal gamma-photon emitters was developed. This method rigorously considers the contribution to the absorbed dose from both direct and scattered radiation and gives results in terms of absorbed fractions, specific absorbed fractions and dose build-up factors. Appropriate equations that utilize these different quantities are given for absorbed dose calculations. Absorbed fractions for both point sources and uniformly distributed sources in different target shapes and sizes for various source energies are given in graphical form to enable accurate interpolation. Specific absorbed fractions and dose build-up factors for a central point isotropic source are given for various energies and distances from the source, in both finite and infinite tissue equivalent media. The effect of a boundary on the values of specific absorbed fractions and build-up factors is discussed. Variation of these quantities with energy and size of the target is presented graphically. (auth) (UK)

38584 REDUCING RADIATION DOSES. Public Health Rep. (U.S.), 84: 414(May 1969).

Patient radiation doses resulting from administration of radioiodine in thyroid gland function tests may be reduced to 1/10,000th of current levels by a new detection system developed by the Bureau of Radiological Health, Public Health Service. The system combines ultrasensitive and accurate techniques for detecting thyroid gland uptake of radioiodine with methods for using ^{123}I, that has a lower energy γ emission than the conventionally used ^{131}I. About half the dose reduction results from the use of ^{123}I. A method was developed for producing highly pure ^{123}I through decay of cyclotron-produced ^{123}Xe. The ^{123}Xe generator can be shipped directly without laborious chemical separation, having maximum ^{123}I content upon receipt by the user. Furthermore, elimination of most of the ^{124}I contamination found in presently available ^{123}I increases shelf life and permits use of very high spatial resolution collimators or lenses. In the conventional measurement technique, the detector is held 10 in. from the neck to compensate for the lack of depth correction. In the new detection method, the detector is placed directly against the neck, thereby greatly increasing measurement sensitivity. A depth correction factor permits more accurate interpretation of the radioactivity count. (BBB)

38585 THE ADAPTATION OF A TABLE-TOP ELECTRONIC CALCULATOR TO COMPLETE ^{60}Co RADIATION DOSIMETRY AND TREATMENT PLANNING. Koplow, Harold; Feldman, Merrill I.; Spira, Jacob (Lynn Hospital, Mass.). Radiology, 92: 163-4(Jan. 1969).

The cost and limited availability of currently programmed computers or time-sharing has considerably limited the application of this aspect of optimizing cancer treatment by radiation. Calculations are presented by which the complete dose-time programs were derived for use in a relatively inexpensive table-top electronic calculator for cobalt-60 teletherapy. With this equipment the radiotherapist can instantaneously determine the treatment time of any given field based on either the percentage depth dose or the tumor-air ratio method of calculation. The computer input is reduced to three variables: the distance of the tumor from the skin, the dimensions of the treatment portal, and the prescribed daily radiation dose. The resultant treatment time is displayed in three-figure accuracy with interpolation for any field size or adjustment for output change by cobalt-60 decay. Isocentric full or partial rotational treatment times may also be determined in a separate computer program. All programs were prepared for the Wang Model 370 system and are recorded on verified punch cards for repeated use. This serves to eliminate operator error, reference to external extrapolation tables, and time-consuming, error-prone manual calculation. (C.H.)

38586 BETA PARTICLE DOSIMETRY IN TRABECULAR BONE. Spiers, F. W. (Univ. of Leeds, Eng.). pp 95-108 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

A method of describing the physical dimensions of trabecular bone is proposed in which the structure is characterized by distributions of linear path lengths through the bone trabeculae and through the marrow cavities. Examples are given of preliminary measurements on sections of a human vertebra and of the femur of a Beagle. Calculations of the mean dose to trabecular marrow were made in terms of the β particle energy deposited in marrow by particles crossing the cavities according to the measured distribution of path lengths. Results were obtained: for the variation in mean dose to marrow of a lumbar vertebra with mean β particle energy, and for the dose to marrow in the Beagle femur from internal ^{90}Sr + ^{90}Y contamination. The results for the Beagle bone were compared with preliminary measurements of mean marrow dose, using very fine grain LiF thermoluminescence dosimetry. (auth)

38587 A REVISED ESTIMATE OF MAXIMUM PERMISSIBLE BURDEN FOR ^{90}Sr. Marinelli, L. D. (Argonne National Lab., Ill.). pp 409-16 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

A maximum permissible burden (MPB) of 9.5 μCi of ^{90}Sr is proposed for adult radiation workers. It is based on the MPB of 0.1 μCi of ^{226}Ra and the ratio of average skeletal doses from ^{90}Sr and ^{226}Ra for equal incidences of osteosarcomas in mice. (auth)

38588 HYGIENIC ASSESSMENT OF RADIOACTIVE AEROSOLS AT EXPERIMENTAL NUCLEAR REACTORS. Alferov, M. V.; Bad'in, V. I.; Sayapin, N. P. Gig. Sanit., No. 12, 43-8(Dec. 1968). (In Russian).

Radiation hazards from β-radioactive aerosols may be expressed by the average dose of internal radiation on the day of inhalation. The distribution of radioactive aerosols in the environs of reactors is subject to the ordinary logarithmic law. A new method is suggested for determining the doses of internal radiation following inhalation of short-life polycomponent aerosols. The method is based on the monitoring of the coefficient of their retention in the respiratory organs, on determining the average radiation energy, and on assessing the accumulation and dissociation curves. By means of this method it is possible to determine the maximum permissible concentration of short-life aerosols for each reactor without identifying separate isotopes. The retention coefficient of the investigated radioactive aerosols in the respiratory organs of man amounts to an average of 45%, and the average doses of internal radiation of lungs under conditions of the ordinary running of reactors are within the limits of 0.05 to 1 ber/year. (auth)

38589 EFFECTIVE TRANSMISSION OF THE HUMAN THORAX FOR PHOTONS FROM ^{239}Pu, ^{241}Am, AND OTHER LOW-ENERGY EMITTERS. Bukovitz, A. G.; Sayeg, J. A.; Spritzer, A. A.; Brodsky, A. (Univ. of Pittsburgh). Health Phys., 17: 71-5(July 1969).

Dose evaluations for inhaled radioactive isotopes by means of external counting methods are difficult due to the self-shielding characteristics of the human thorax. A study of the self-shielding characteristics of the human thorax was undertaken for low-energy photon emitters including ^{239}Pu, ^{241}Am, ^{125}I, ^{99m}Tc, and the x-rays of ^{198}Au, using a human cadaver as the phantom. Activity distributions were obtained for both the "free-in-air" and phantom (lung region) geometries with NaI crystals. Preliminary results indicate that the activity observed from the phantom is not always less than the "free-in-air" case, but is actually greater

for certain geometries. Average self-shielding factors, defined as the ratio of "free-in-air" to phantom counts, were found to be as follows for a centrally located line distribution: ^{239}Pu (17 keV) −4.35; ^{125}I (30 keV) −3.51; ^{241}Am (60 keV) −1.02; ^{198}Au (70 keV) −0.71; and ^{99m}Tc (140 keV) −1.3. The data for ^{99m}Tc were taken with a 2 in. dia × 2 in. NaI crystal close to the chest; the other data were taken with a 2 in. dia × 1 mm crystal. (auth) (UK)

38590 PATIENT DOSIMETRY. Pychlau, Herbert; Wachsman, Felix. Strahlenschutz Forsch. Prax., 7: 21-9(1967). (In German).

Factors that affect x irradiation doses to patients were discussed. These included tube voltage, current, filtering, target distance, exposure time, field size, target dimensions and irradiation hardness. Measures of irradiation magnitude derived from these factors included dose rate, total dose, surface dose, and integral dose. Procedures and equipment for dosimetric measurements in patients were described and illustrated. Relations between integral dose and incident radiation energy were compared with the surface dose parameter for various radiation qualities produced by filtration with up to 7 mm of Al for a thorax phantom. A dosimeter for use in patient dosimetry was described. The invariant relation between focal distance and surface area was illustrated for several doses and field sizes. Legal and medical problems associated with human dosimetry, and the need for continuous protection of patients against irradiation, were discussed. (BBB)

38591 RADIATION DOSIMETRY WITH THE ^{90}Sr-APPLICATOR, AND ITS PROPHYLACTIC EFFECT ON THE RECURRENCE OF PTERYGIUM AND BETA-RADIATION CATARACT. Yamada, Eiichi (Tokyo Metropolitan Police Hospital). Nippon Ganka Gakkai Zasshi, 73: 438-45(Apr. 1969). (In Japanese).

Precise knowledge of the physical characteristics of β-ray applicators, that vary significantly with each apparatus, is an essential prerequisite to a safe and complete β-ray radiotherapy. Radiation dosimetry with the ^{90}Sr-applicator (Buchler Co.) revealed that its dose rate is 730 rad/min on the surface and its 18.5% level at 3 mm depth in tissue. The radioactivity of this apparatus, that was estimated to be 50 mCi at the time of installation 11 years ago, was found to be 33.64 mCi. It is considered from the safety aspects that any one operator may perform 30 cases of radiotherapy in a year without exceeding the permissible exposure level. The prophylactic effect of β-radiotherapy with the ^{90}Sr-applicator on the recurrence of pterygium was found significant; there were nine cases of recurrence among 153 treated during the period of 10 years since 1956, that is 5.88%. Cataract was observed in 17 cases by the follow-up of 39 cases (43.6%), for more than 3 years after radiotherapy which exceeded the incidence of cataract examined about 3 years ago, i.e., 9 cases in 29 (31.0%) suggesting the progression of cataract. In three cases of cataract no sign of disturbance was noticed in the lens at the time of the preceding examination. The prophylactic dose against the recurrence of pterygium was estimated to be 3,000 to 4,000 rep and the permissible exposure level to the lens was 300 to 500 rep. (NSA of Japan)

38592 SIMPLIFIED TREATMENT PLANNING PROCEDURES AND THE CONCEPT OF NORMALIZED TISSUE DOSE. Gopala Rao, U. V. (Johns Hopkins Univ., Baltimore, Johns Hopkins Hospital, Baltimore). Strahlentherapie, 137: 654-62(June 1969).

A treatment planning procedure based on single-field isodose charts with the 100% reference point located at a considerable depth in tissue instead of at the surface is described. The procedure makes it possible to consider a large number of treatment plans with each patient in a much shorter time than is required to obtain a single plan by the conventional techniques. The calculation of treatment times is reduced to a single arithmetical division by providing for routine use tables of the Tissue Dose Rates, which can be generated easily from standard depth dose data. However, because of several inherent errors in the measurement of surface and air dose rates, it is suggested that central axis depth dose information be made available in the form of what may be called the Normalized Tissue Doses. A definition for Normalized Tissue Dose is proposed and the advantages of this concept are discussed. (auth)

38593 OXFORD NSD CALCULATOR FOR CLINICAL USE. Winston, Barry M.; Ellis, Frank; Hall, Eric J. (Churchill Hospital, Oxford). Clin. Radiol., 20: 8-11(Jan. 1969).

The methods of use of the Ellis Nominal Standard Dose equation are described; this equation relates dose, number of fractions and time of treatment to a parameter representing normal tissue tolerance. The equation is in an index form and is inconvenient to solve. A specially constructed slide-rule calculator is described which facilitates the evaluation of the treatment parameters. (auth)

38594 THE PATIENT EQUIVALENCE OF THE RANDO PHANTOM FOR COBALT GAMMA RAYS. Saylor, W. L.; Adams, Betty L. (Walter Reed General Hosptial, Washington, D. C.). Radiology, 92: 165(Jan. 1969).

The RANDO average man or average woman phantoms are especially designed for use in connection with radiation dosimetry studies. The construction of the phantom consists of a special thermosetting synthetic rubber which is molded around a natural human skeleton. Lungs are simulated with a special foam reported to have a density of 0.32. A RANDO average man phantom was used for the development of a number of special dosimetry techniques using ^{60}Co γ rays and 2 MVp x rays. The exposure in the phantom was measured with film or miniature ionization chambers. Measurements were also made in 88 patients treated with a rotational cobalt-60 teletherapy unit. During treatment the transmitted radiation exposure rate was recorded, using an ionization chamber mounted in the beam catcher. After a patient was set up and treated the phantom was placed on the couch and treated in a manner identical to that of the patient, i.e., with the same anatomical site, field size, source-skin distance, and field shaping, if any. Care was taken to ensure that the central ray passed through the same portion of the couch for both the patient and phantom measurements. Since the phantom cross section thickness in the anatomical site of interest was usually not equal to the patient thickness a correction had to be applied to the exposure rate data obtained with the phantom in the beam. For this purpose it was necessary to obtain attenuation data for a series of thicknesses in both the soft tissue and lung portions of the phantom. The results of the transmission measurements on the patients and phantom, corrected for differences in the cross-sectional thicknesses, are given for a variety of anatomical regions. Although the transmission through equal thicknesses of different patients varied considerably, it was concluded that the average patient represents a greater stopping power for ^{60}Co γ rays, centimeter-for-centimeter, than does the RANDO phantom. (C.H.)

38595 DEPTH THERAPY WITH A MOVING BEAM OF FAST ELECTRONS. Fehrentz, Dieter; Kuttig, Helmut; Hymmen, Ursula; Fornusek, Arthur (Univ., Heidelberg). Strahlentherapie, 137: 509-17(May 1969). (In German).

Radiotherapy with fast electrons possesses distinct disadvantages because of high skin doses, high doses to the tissues between skin and tumor, and the pronounced effect of inhomogeneities on dose distribution. Experimental measurements in a homogeneous and in a non-homogeneous Alderson phantom show that these can largely be overcome by using moving beam methods. The influence of energy, pendel axis, field surface, axis-depth and source-axis distance on dose distribution has been examined. The practical aspects of the method are described. The results show a distinct advantage of this method when compared to static fields. (auth)

Radiation Protection

Refer also to abstracts 38508, 38612, 38661, 38780, and 38823.

38596 (NP-17969) THEORY OF COLLECTION OF AIRBORNE PARTICLES BY FIBROUS FILTERS. Dawson, Stanley Verne (Harvard School of Public Health, Boston, Mass.). July 1969. 239p.

Thesis.

A review of previous work indicates disagreement between flow measurements and the theoretical predictions based upon the assumption of a typical fiber in a filter of uniform solidity. The review also indicates the need for theoretical prediction of collection of particles by inertial force for the case of a fiber within an array. For available patterns of flow around the typical fiber, the flow resistivity predicted on the basis of the customary assumption of uniform solidity in the filter is compared to published measurements of resistivity. The disagreement is resolved by proposing that a parallel flow through paths of different solidity has occurred in the filter. In the mathematical model chosen, the paths of parallel flow are each of uniform solidity and the pattern of flow around the typical fiber is that of Spielman and Goren (1968). Methods of calculating the efficiency of a single fiber in collecting particles from the air stream through a region of uniform solidity are reviewed, and the published results are quoted in the case of Brownian motion of particles having a significant relative diameter. In the case of collection of particles due to their inertial force, classic trajectory calculations performed on a high-speed digital computer for the flow pattern of Spielman and Goren are described, and the resulting efficiencies are presented, including cases of particles having a significant relative diameter. An expression for efficiency due to combined effects of Brownian motion and inertial force is constructed. The accuracy

of the expression is limited to small Knudsen and Reynolds numbers and to small relative diameter of the particle. In order to predict penetration of particles through the parallel-flow model of the filter, paths of only two distinct solidities are considered for each filter. A comparison of the predictions and of published measurements of penetrations shows the usefulness of the present predictions. (W.H.K.)

38597 (UR-49-1080) MICROWAVE STANDARDS: A COMPARATIVE ANALYSIS. Michaelson, Sol M. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). Apr. 23, 1969. Contract W-7401-eng-49. 11p. (CONF-690617-1). Dep. CFSTI.

From Industrial Neurology Congress, Prague, Czechoslovakia.

Factors that must be considered in quantification of the biological response to microwaves are discussed. Recommendations for developing a more rational and realistic approach to the development of standards for human exposure to microwaves are considered. The importance of including biophysical factors in relation to functional responses of the body in the development of standards for maximum permissible exposure is pointed out. Soviet levels for maximum permissible exposures are compared with those of the United States. The importance of biomedical investigation of specific effects, engineering studies of the characteristics of the equipment, field surveys of power levels actually encountered, and development work on means of protection in establishing maximum permissible levels is pointed out. A table of recommended maximum permissible intensities for radiofrequency radiation is presented. (H.L.W.)

38598 PROBLEMS OF HYGIENE AT RADIOLOGICAL CENTERS IN SOUTH BOHEMIA. Truelle, M. A. (Krajska Hygienicka Stanice Jihoceskeho Kraje, Ceske Budejovice, Czech.). Ces. Radiol., 21: 408-14(1967). (In German).

Changes in the operation of radiological centers in South Bohemia that have improved working conditions are reviewed. As the result of these changes no new cases of excessive professional radiation exposure have been reported during the past two years. The radiation doses received by 36% of the personnel working with x rays, as measured by film dosimeters during 82% of the months reviewed, did not exceed 5 mR. The maximum permissible irradiation dose was never exceeded during the period studied. There were also substantial reductions in the irradiation dosages received by patients. These included 145 fluoroscopies, 721 radiographs, and 389 photofluorograms/1000 inhabitants. The numbers of persons engaged in radiological work included 3.6 radiologists, 18.5 physicians, and 21.2 technicians/100,000 inhabitants of South Bohemia. (BBB)

38599 DENTAL X-RAY PROTECTION. Richards, A. G. (Univ. of Michigan, Ann Arbor). Dent. Clin. N. Amer., 631-41 (Nov. 1968).

The sources of radiation exposure within the dental office were identified, and the various methods for achieving remarkable reductions in exposure of patient, dentist, and ancillary personnel were discussed. Reduction in the exposure of the patient's face can be brought about by reducing the area of exposed skin and by reducing the amount of radiation used in exposing the film. Collimation of the beam reduces the facial area irradiated. Approximately 20% less radiation of the type generated at 90 kVp is required to produce the same blackening of the film as is produced by radiation generated at 65 kVp. Addition of the proper filtration to an improperly filtered beam can reduce the exposure of the patient's face by about one-half. The use of a lead apron on the dental patient to further reduce gonadal exposure is unnecessary. Protection for the operator is achieved by avoiding exposure to the primary beam and keeping exposure to scattered radiation at a minimum. Radiation barriers may be necessary for the safety of persons in areas adjacent to the dental radiography room. However, in many dental offices the existing walls generally will suffice as the protective barriers. (BBB)

38600 EQUIPMENT FOR THE SAFE APPLICATION OF RADIOACTIVE PHOSPHORUS TO POTATOES. Emmond, G. S. (Canada Dept. of Agriculture, Experimental Farm, Indian Head, Saskatchewan). Can. J. Soil Sci., 48: 222-4(1968).

Equipment used to apply P-32-labeled monoammonium phosphate to an experimental potato plot is described. A box is used consisting of two compartments, one containing the envelopes of fertilizer and lined with lead shielding to protect the operator during application of the radioactive fertilizer during the planting operation. The technique is outlined for safe handling of this material. Exposure doses to the operators are constantly checked with a Geiger counter. (Canada)

38601 INVESTIGATIONS OF CHEMICAL RADIATION PROTECTION FOR RABBIT EYES AGAINST EFFECTS OF ^{60}Co γ RADIATION. Ruether, W.; Jacobi, K. W.; Kovacs, G.; Graul, E. H.; Neubauer, H. (Philipps-Univ., Marburg, Ger.). Klin. Monatsbl. Augenheilk., 154: 232-8(Feb. 1969). (In German).

Radiation protection afforded by serotonin (5-HT), adenosin monophosphate (AMP), cysteamine (MEA), and β-aminoethylisothiuronium (AET) to eyes of rabbits exposed to 1500 rad of ^{60}Co γ irradiation was studied. Some alopecia of the eyelids was observed. Several opacities of the lens developed over an interval of 450 days primarily in the region of the equator and in the anterior portion. Animals that had received a combination of MEA, 5-HT, and AET 20 min before irradiation developed lens opacities less frequently and more slowly than in untreated animals. A combination treatment with 5-HT and AMP was less effective in preventing and delaying development of lens opacities and cataracts. The development of opacities in the treated animals was delayed by 1 or 2 months beyond the time when they were observed in untreated animals. (BBB)

38602 RADIOLYSIS AND RADIOPROTECTIVE EFFECT OF GLUTATHIONE. Bonotto, S. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium); Netrawali, M. S. Int. J. Radiat. Biol., 15: 275-8(1969).

Gamma irradiation of a glutathione solution resulted in the formation of free glutamic acid, cystic acid, cystine, glycine and two other compounds. It was thought that cysteine and other radiolytic products of glutathione contributed to the total radioprotective effect of glutathione on Escherichia coli. (H.L.W.)

Safety Procedures

38603 (AD-677369) HEALTH PHYSICS-PROCESS CONTROL REFERENCE MANUAL. VOLUME I. Van Den Berg, Alan J. (Army Engineer Reactors Group, Fort Belvoir, Va. Engineering Dept.). July 1, 1966. 240p. CFSTI.

The manual is designed for use by Nuclear Power Plant Process Control Specialists. It contains health physics and water chemistry procedures for guidance in plant operation. Although this manual cannot give detailed recommendations, necessary and sufficient for all conditions, it gives general recommendations suitable for typical plant use. Volume I contains sections on personnel monitoring, radioactive materials control, and decontamination. (TAB)

38604 (AD-677371) HEALTH PHYSICS-PROCESS CONTROL REFERENCE MANUAL. VOLUME III. Van Den Berg, Alan J. (Army Engineer Reactors Group, Fort Belvoir, Va. Engineering Dept.). July 1, 1966. 301p. CFSTI.

The manual is designed for use by Nuclear Power Plant Process Control Specialists. It contains health physics and water chemistry procedures for guidance in plant operation. Although this manual cannot give detailed recommendations, necessary and sufficient for all conditions, it gives general recommendations suitable for typical plant use. Volume III contains sections on personnel access control, radiation and contamination control, accident/incident control, bioassays, radiochemistry for health physics operations, water chemistry (analytical procedures, general chemical procedures, laboratory supplies). (TAB)

38605 THE TASK OF THE HEAD STOMATOLOGIST IN THE PREVENTION OF OCCUPATIONAL ACCIDENTS IN DENTAL PRACTICE. Tonne, E. Deutsch. Stomatol., 18: 661-71(Sept. 1968). (In German).

The constitution of the German Democratic Republic guarantees the protection of the capacity for work. The tasks of the medical personnel in the prevention of occupational accidents are determined by law. Some of these protective labor laws, that apply to the stomatological laboratory and the stomatological practice, are explained. Special attention is paid to the model-casting laboratory, the proper handling of the turbine and the use of x rays. (auth)

38606 ALKALINE PHOSPHATASE IN THE URINE OF WORKERS IN A CHEMICAL URANIUM ORE PLANT. Pehr, F.; Novosad, F.; Nosek, J. Cas. Lek. Cesk., 107: 813-9(June 28, 1968). (In Czech).

The optimum conditions for urinary alkaline phosphatase activity determination were shown to be as follows: 5 hr dialysis of urine, pH 10.3, 30-min incubation of the specimen of dialyzed urine with substrate (disodium phenylphosphate), presence of magnesium as secondary activator of urinary alkaline phosphatase in disodium phenylphosphate solution. Urinary alkaline phosphatase activity was detected in all of the urine specimens under test. In healthy humans this activity is very low, yet reproducibly detectable. Its mean value found in control examinations was 0.76 ± 0.39 K.A.U. Some workers employed in the wet operating units of the chemical uranium ore concentrating plant excreted urines with higher urinary alkaline phosphatase activities. In the

group under investigation, their values amounted up to three King Armstrong Units. This is the reason why the mean value for this group is higher (0.98 ± 0.54 K.A.U.) than in the control group. In this group of subjects with higher urinary alkaline phosphatase activities, 88% of subjects showed a concomitant slight urinary finding. The most frequently occurring findings included trace up to opalescence of albumin and white blood cells and mucus fibers in the sediment. In the group of workers with normal urinary alkaline phosphatase activities slight urinary findings occurred in 25% of cases. The type and degree of urinary findings as determined for one and the same worker at repeated examinations made in the lapse of time showed a wide variation including even normal levels. (auth)

38607 RATIONALIZATION OF LABOR PROCEEDINGS FOR EVALUATION OF DOSIMETER FILMS FOR RADIATION PROTECTION SUPERVISION. Hirsch, A.; Makiola, Klaus. Roentgenpraxis, 22: 40-9(Feb. 1969). (In German).

For the rational comprehension of the data from dosimeter films, automatic data processing by computer was considered. The calculation of the personnel dose from the measured darkening of the film should be possible by a suitable approximation method. An automatic development machine for the development of dosimeter film was developed. The precautions to be taken in the operation of the machine are given. The method used for the dose calculation is described, and the procedure for data processing is given. (J.S.R.)

38608 CLINICAL AND STATISTICAL DATA ON DOCTORS EXPOSED TO IONIZING RADIATION. Guardascione, V.; di Bosco, M. Mazzella; Galasso, F. S. Minerva Med., 59: 4091 (Sept. 30, 1968). (In Italian).

Between February 20, 1958, and December 31, 1965, 180 cases of radiation injuries resulting from the accidental exposure of physicians were reported. These cases are broken down into the number of cases of radiodermatitis, neoplasms of the skin or of deep-lying organs, hemopathy, and lesions of the eye. (J.S.R.)

38609 RISKS AND PROTECTION FROM IONIZING RADIATION. Parmegianni, L.; Polvani, C.; Pancheri, Giovanni; Bellion, B.; Ghislandi, E.; Bollini, V. Minerva Med., 59: 4080-6 (Sept. 30, 1968). (In Italian).

Five brief monographs are presented on the risks and protection from ionizing radiation. The evolution of standard concepts on radiation, biological and physical bases of protection against radiation, protection from ionizing radiation in industry, risks and protection from ionizing radiation in the nuclear industry, and risks and protection from ionizing radiation in radiology are the topics discussed. (J.S.R.)

Legal Aspects

Refer also to abstracts 38587, 38909, and 38914.

38610 (LIB/Trans-202) THE MAXIMUM ADMISSIBLE CONCENTRATION OF ^{222}Rn IN AIR. Hamard, Jean; Beau, Paul-Georges; Ergas, Alain (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by Eric R. Corran (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from report CEA-R-3583. 28p. Dep.

Problems involved in determining the maximum admissible concentration (MAC) of ^{222}Ra in inhaled air are reviewed, with emphasis on establishing MAC of radon and its daughter products, ^{214}Po and ^{214}Bi, in uranium mines. Values for the MAC for radon proposed by the AIEA, EURATOM, ICRP, France, and the United States, are compared and criteria used for establishing the MAC values are discussed. It is pointed out that no value for the MAC of radon in air has yet been derived that is easily measured and unanimously acceptable. It is proposed that an epidemiological study be conducted to compare the risk of lung cancer in uranium miners with that in those mining other ores. The need for more precise model of the human pulmonary system than that for adoption by the ICRP in estimations of radon retention is pointed out. (C.H.)

38611 (PHS-999-RH-37) REGULATIONS, STANDARDS, AND GUIDES PERTAINING TO MEDICAL AND DENTAL RADIATION PROTECTION. AN ANNOTATED BIBLIOGRAPHY. Snavely, David R.; Kumbier, Larry G.; Thompson, Mark J.; Setter, Lloyd R. (Bureau of Radiological Health, Rockville, Md.). June 1969. 73p. Dept. of Health, Education, and Welfare, Rockville, Md. Free.

An annotated bibliography of standards, regulations, and guides pertaining to medical and dental ionizing radiation protection is presented. Included are annotations of general standards, guides and recommendations; standards on the safe operation, handling, and design of radiation equipment and sources; and standards and guides pertaining to radiation measurement. Since the terminology for regulations, standards, and guides is not uniform among the Federal and State governments, military organizations, and nongovernmental organizations, the annotated documents are designated as Class A (established or adopted by a governmental body acting under the authority of an act, law, or statute), Class B (adopted by consensus of a committee(s) or commission(s) of technical competence in standards-setting organizations), or Class C (not adopted by a standards-setting organization, but contains information pertinent to the preparation of suitable standards or regulations). The annotations include identification of the document, type of standard, intended complier, intended benefitter, limits and specifications, and general guidance. (auth)

38612 AUSTRIA: BILL ON RADIATION PROTECTION. Nucl. Law Bull., No. 3, Suppl., 22p.(Apr. 1969).

A federal bill proposed by the National Committee in Austria regarding measures for protecting the life and health of persons and their descendants against injury by ionizing radiations is presented. The bill includes provisions regarding human exposure to ionizing radiations, the building of nuclear installations, general provisions regarding radiation protection, radiation monitoring by the authorities, provisions of a penal nature, and the role of federal and local authorities in administrating the bill. (E.R.B.)

Medicine

Refer also to abstracts 38255, 38608, 38609, and 39592.

38613 PROCEEDINGS OF THE TWENTIETH ANNUAL SCIENTIFIC SESSION OF THE JAMES EWING SOCIETY, PASADENA, CALIFORNIA, APRIL 16-19, 1968. Scott, Wendell G. (ed.). Cancer, 22: 901-1088(Nov. 1968). (CONF-680460).

Separate abstracts were prepared for eight papers for inclusion in NSA. Seventeen additional papers on different aspects of cancer research are included that are outside the scope of NSA. (C.O.)

For abstracts of individual papers see: 38709-38716.

Protective Substances

Refer also to abstracts 38007, 38478, 38498, 38540, 38541, 38549, 38780, 38784, 38789, 38791, 38823, 38885, and 38899.

38614 (COO-1818-1) PROTECTION OF MICE AGAINST LETHAL X RADIATION WITH A CELL-FREE COMPONENT OF SPLEEN. Technical Progress Report, September 1, 1968-May 15, 1969. Donaldson, David M.; Allen, A. Lester (Brigham Young Univ., Provo, Utah). Contract AT(11-1)-1818. 6p. Dep. CFSTI.

A cell-free preparation from mouse spleen injected into mice following exposure to a lethal dose of x radiation protected the irradiated mice from death. The protective component has a molecular weight of approximately 70,000 and was derived from the DAL strain of mice obtained from Redwood Game Farms, Salt Lake City, Utah. Similar splenic preparations from CBA, CD-1, and CF-1 strains of mice did not protect against radiation, but the CD-1 and CBA mice could be protected with preparations prepared from spleens of DAL mice. The weight of a spleen from the DAL mice was 225 to 240 mg. In contrast, the spleen weight of the other strains varied between 70 and 120 mg. It was possible to increase the spleen size in these latter strains of mice by the i.p. injection of macerated spleens from DAL mice. Furthermore, the injection of macerated tissue from enlarged spleens of CBA mice induced splenomegaly in normal CBA mice. The splenic hyperplasia was evident 10 to 13 days after the injection of macerated spleen and was believed to be caused by an infection. In contrast to the negative results with normal spleens, preparations from the enlarged spleens of CBA and CD-1 mice protected against the lethal effects of total-body irradiation. (auth)

38615 RADIOTHERAPY IN MANAGEMENT OF CARCINOMA OF THE LARYNX. Rider, W. D. (Princess Margaret Hospital, Toronto). Appl. Ther., 10: 183-6(Mar. 1968).

Radiobiologic principles applicable to the treatment of laryngeal carcinoma and the prevention of radiation injuries are considered. The most common current practice is to deliver equal daily fractions of radiation over a period of weeks, which is effective in the early cancers. However, there is evidence that by increasing the

size of the dose fraction and increasing the interval between fractions, the more radioinsensitive cancers can be made to respond. By raising the oxygen tension in the hypoxic zone of a tumor to normal range, these cells can be made to respond to radiation. In clinical practice, this can be achieved by irradiating the patient in a tank under high-pressure oxygen. Neutron irradiation is much less dependent upon the oxygen concentration than x or γ rays. High-energy radiations, e.g., ^{60}Co or megavoltage x rays, are superior to conventional 250 kV x rays because of the difference in absorption of energy between the soft tissues and the cartilages of the larynx. With low-energy radiation, much more energy is absorbed in cartilage than in soft-tissue structures, thus increasing the risk of cartilage necrosis. With high-energy radiation the absorbed energy is no greater in cartilage than in soft tissues, and the risk of cartilage necrosis is very much less. A fairly protracted course of radiation seems to give the best functional result. (BBB)

38616 OXYGEN DIFFUSION AND OXYGEN DEPLETION PROBLEMS IN RADIOBIOLOGY. Boag, J. W. (Inst. of Cancer Research, Sutton, Eng.). Curr. Top. Radiat. Res., 5: 141-95(1969).

Steady-state and time-dependent oxygen diffusion problems are discussed in relation to graphic solutions; the problems are divided into secondary categories according to their geometrical symmetry, i.e., whether flow is linear along one axis only, radial in two dimensions, or radial in three dimensions. Steady-state diffusion with consumption is discussed relative to its geometrical symmetry and the importance to radiobiology is noted. Time-dependent diffusion problems classified according to geometry (cylindrical, plane, or spherical) or boundary conditions (free diffusion across the boundary or fixed concentration on it) are then discussed and graphically illustrated. These models are then applied to actual biological objects such as bacteria or body cells. The amount of bubbling necessary to oxygenate or deoxygenate a solution is considered. A discussion on oxygen depletion by pulsed or high dose-rate irradiation follows. (C.O.)

38617 OXYGEN EFFECT IN RADIATION THERAPY. van den Brenk, H. A. S. (St. Thomas' Hospital, London). Curr. Top. Radiat. Res., 5: 197-254(1969).

The role of the oxygen effect in clinical radiotherapy is evaluated. Various strategies that attempt to overcome the radioresistance of tumors, which is attributed to lack of oxygen, such as the use of oxygen at increased pressure (high pressure oxygen or HPO) during irradiation are analyzed. Oxygenation is discussed in relation to normal tissue oxygenation and tissue growth, physiological aspects of tissue oxygenation, adaptive normal tissue growth and angiogenesis, and neoplastic growth and blood supply. Other areas discussed in depth include the quantitative aspects of dose-effect relations in radiotherapy and the oxygen effect, dose fractionation and HPO research results, general aspects of damage to normal tissues and the effects of oxygen, radiosensitivity of special tissues (skin, spinal cord, nerve cells, and salivary glands) in HPO, factors affecting tumor clearance rates, and techniques for radiotherapy based on the oxygen effects (tourniquet hypoxia, regional oxygenation with hydrogen peroxide, and neutron therapy). The discussion was concluded with the statement that the capacity of oxygen to sensitize cells to the action of x radiation was proved and that anoxia or severe hypoxia causes radiosensitivity of a tissue in vivo to decrease almost threefold. (C.O.)

38618 THE COURSE OF RADIATION DISEASE IN HYPER- AND HYPOTHYREOTIC RATS. Slebodzinski, A. (Inst. of Animal Husbandry, Krakow); Srebro, Z. Folia Biol. (Krakow), 17: 145-58(1969).

Six groups of adult hooded rats were whole-body x-irradiated with 800 R and 1000 R. One group in the 1000 R irradiated and one group in the 800 R irradiated animals had the thyroid region protected with lead during irradiation. Two groups of the 800 R irradiated animals were additionally treated, one with thyroxine and the other with propylthiouracil, for 5 pre-irradiation and 7 post-irradiation days. The animals irradiated with 800 R were killed on the 7th post-irradiation day, the 1000 R irradiated ones serving for the study of post-irradiation survival. The results show that a hyperthyroid state created by thyroxine treatment aggravated the course of the radiation disease as evidenced by a considerable loss in body weight in the post-irradiation period. Conversely, propylthiouracil administration significantly reduced the post-irradiation weight loss. Protection of the thyroid region from irradiation resulted in shorter survival time (after 1000 R). Functional tests of the thyroid revealed a hypothyroid state in the whole-body 800 R irradiated animals on the 7th post-irradiation day. A relative hyperactivity was observed in the 800 R irradiated animals that had the thyroid region protected during irradiation. The paraventricular nuclei of the hypothalamus showed a statistically significant depletion of the stainable neurosecretory material in all groups of 800 R irradiated animals. A depletion of the neurosecretory material was also observed from the neural lobe and the supraoptic nucleus, from the latter only in the whole-body irradiated animals that were additionally treated with thyroxine. (auth)

38619 AN EXPERIMENTAL STUDY OF THE EFFECT OF FOLIC ACID ON RADIATION INDUCED LEUCOPENIA. Vitale, V.; Rovetta, G. (Univ., Genoa). Minerva Med., 60: 1801-11 (May 9, 1969). (In Italian).

A brief account is given of the result of the action of radiation on living organisms, with particular reference to the molecular changes induced thereby. It is suggested that folic acid be employed to limit the leucopenizing effect of radiation. Experimental evidence of protection offered by folic acid following whole-body irradiation of the laboratory animal was obtained from the evaluation of peripheral leucocyte values and survival curves. Statistical elaboration of the data showed that this preparation had a protective action. Unlike other radioprotectors, it can be used even after exposure. (auth)

38620 EFFECT OF RADIOPROTECTORS ON EXPERIMENTAL PARATYPHOID INFECTION AND MICROBIAL REPRODUCTION. Samoylov, N. N. (Tomsk Medical Inst., USSR). Farmakol. Toksikol., 31: 463-7(1968). (In Russian).

Mice (695) weighing 18 to 22 g were infected after a 24 hr fast with Salmonella paratyphi bacilli by mouth or intraperitoneally. Aqueous solutions of radioprotectors were administered in a 150 mg/kg dose. Single prophylactic administration of cystamine, aminoethylisothiuronium (AET), or ethylisothiuronium (ET) by mouth or intraperitoneally had no significant effect on the course of the infection by mouth. Intraperitoneal infection and injection prolonged the process in mice receiving cystamine or ET. Under analogous conditions AET had no effect on the course of the infection. The bacteriostatic effect of cystamine (1:51 200 ratio) was demonstrated in 14 investigated microbial species. AET and ET showed bacteriostatic action in a 1:200 ratio in 4 and 13 species, respectively. The cystamine effect was demonstrated on a meat-peptone medium containing amino acids but was completely absent on a medium containing peptones and on the glucose-salt medium. (JPRS)

38621 RADIOPROTECTIVE EFFECTS OF NUCLEIC ACID HYDROLYSATES ON FAST NEUTRON-IRRADIATED YEAST CULTURES. Indik, V. M. Fiziol. Zh., Akad. Nauk Ukr. RSR, 14: 404-6(May-June 1968). (In Ukrainian).

Studies of yeast cultures of Saccharomyces vini of Megri-139-B strain irradiated by fast neutrons with 10 Crad doses showed that nucleic acids of bacterial origin and products of enzyme fermentation hydrolysis exert effective radioprotective effects in yeast. (R.V.J.)

38622 PROTECTION AND HOST CELL REPAIR OF IRRADIATED LAMBDA PHAGE. I. IRRADIATION OF NORMAL PHAGE WITH ULTRAVIOLET LIGHT. Radman, M.; Roller, A.; Errera, M. (Univ. Libre, Brussels). Mol. Gen. Genet., 104: 142-6(1969).

Phage λ, irradiated with uv light in the presence and absence of the free-radical scavenger and proton donor, cysteamine, were assayed on normal and DNA-repair deficient bacteria. It was concluded that cysteamine protects the phage against lesions of a type that can be repaired by the bacterial DNA-repair systems. Presumably, these are pyrimidine dimers. (auth)

38623 PROTECTION AND HOST CELL REPAIR OF IRRADIATED LAMBDA PHAGE. II. IRRADIATION OF 5-BROMOURACIL-SUBSTITUTED PHAGE WITH NEAR VISIBLE LIGHT. Radman, M.; Roller, A.; Errera, M. (Univ. Libre, Brussels). Mol. Gen. Genet., 104: 147-51(1969).

Phage λ, in which thymine was totally substituted by the analog, 5-bromouracil, were irradiated with near visible light in the presence and absence of cysteamine, a free radical scavenger and proton donor. These phage were then assayed on normal bacteria and on mutants that were unable to repair DNA lesions. It is concluded that these phage suffer three different kinds of lesions: a class that was not reparable, but which could be prevented by cysteamine, suggesting that they are sugar damages; a class that was reparable but was not eliminated by cysteamine, and a class that could be neither eliminated nor repaired. The nature of the latter two types of lesions cannot be surmised at present. (auth)

38624 PROTECTION AND HOST CELL REPAIR OF IRRADIATED LAMBDA PHAGE. III. ULTRAVIOLET IRRADIATION OF 5-BROMOURACIL-SUBSTITUTED PHAGE. Radman,

M.; Roller, A.; Errera, M. (Univ. Libre, Brussels). Mol. Gen. Genet., 104: 152-6(1969).

5-bromouracil-containing λ phage, irradiated with uv light in the presence and absence of cysteamine, was assayed on normal and DNA-repair deficient bacteria. It was found that these phage suffer lesions, of unknown nature, that were neither reparable by the bacterial DNA repair systems nor prevented by cysteamine, a free radical scavenger and proton donor; lesions that were converted to reparable lesions by cysteamine, and that might be sugar damages (perhaps accompanied by pyridimine dimers) that were converted to simple dimers; and irreparable lesions, that did not occur in the presence of cysteamine, and that were probably sugar damages. These latter were the most important, and in large part explain the increased sensitivity to irradiation of 5-bromouracil-substituted phage. (auth)

38625 GLUCOSE, INSULIN MAY INCREASE TUMOR DOSE. J. Amer. Med. Ass., 208: 1284(May 26, 1969).

Injecting glucose and insulin just before x radiotherapy improved tumor response. Single-cell systems were first used and then progress was made to solid tumors in animals. When ascites-bearing mice were killed 8 days after a dose of 1 kRad, the number of cells in the peritoneal cavity of animals receiving insulin, glucose, and radiation was 6.9×10^8. The number with radiation alone was 17.4×10^8; saline alone was 22×10^8, and insulin alone was 25.2×10^8. Experiments with solid tumors showed that in mice receiving glucose-insulin doses, the tumor decreased in size much more rapidly following irradiation. It was concluded that the glucose-insulin combination increased oxygen tension and increased tumor susceptibility to x rays. (C.O.)

38626 VARIATIONS IN THE CELLULARITY OF THE BONE MARROW FOLLOWING LOCAL X IRRADIATION AND ADMINISTRATION OF CYSTEAMINE. Stokke, T. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Scand. J. Clin. Lab. Invest., 22: Suppl. 106, 111-17(1968).

Bone marrow cell counts were made in rats following single exposures of local irradiation with various doses, with and without cysteamine treatment prior to irradiation. Observations were carried out in irradiated as well as nonirradiated (shielded) marrow to study possible abscopal effects. The cellularity of bone marrow of rats exposed to hind-leg irradiation with doses of 400 to 3000 R decreased rapidly and remained at a low level for about 3 days. From the third to the fifth day there was a marked rise in the cellularity. During the ensuing 3 weeks the cell number of the marrow gradually increased towards normal values. In non-irradiated marrow a slight reduction of the cellularity was observed (abscopal effect). Following exposure to doses of 50 and 100 R the reduction in cell numbers was less pronounced, and complete regeneration was obtained in the course of a week. When cysteamine was administered prior to irradiation, the initial cell reduction was not modified, subsequent repopulation was accelerated, and the abscopal effect was reduced. (BBB)

38627 EFFECT ON THE RADIATION SYNDROME OF THE ALBINO MOUSE OF FEEDING OF A YEAST PREPARATION (BIOSTRATH). Fritz-Niggli, H. (Univ., Zurich). Hippokrates (Stuttgart), 38: 812-14(Oct. 31, 1967). (In German).

Mice were exposed to whole-body x radiation, and the biological effect was judged from weight loss and mortality. Some groups of mice received a food additive prepared from wild yeast for several weeks prior to and following irradiation. At 500 R, the food additive significantly decreased the radiation effect; at higher doses, the food additive was ineffective. (H.B.G.)

38628 CHEMOPROTECTION AGAINST THREE MODES OF RADIATION DEATH IN THE MOUSE. Yuhas, John M.; Storer, John B. (Jackson Lab., Bar Harbor, Maine). Int. J. Radiat. Biol., 15: 233-7(1969).

Seven radioprotective agents were tested for their ability to protect the mouse against three radiation-induced modes of death. Six of the seven agents offer relatively less protection against gastrointestinal death than against hematopoietic death, and only one (PAPP) is effective against CNS death. It is proposed that the variations in protection against the three forms of death may be the result of tissue-specific differences in the ability to concentrate and respond to each agent. (auth)

38629 RADIOSENSITIZATION OF BACTERIAL CELLS BY CARBONYL COMPOUNDS. Barnes, J. H.; Ashwood-Smith, M. J.; Bridges, Bryn A. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol., 15: 285-8(1969).

A brief review of radiosensitization of bacterial cells by carbonyl compounds is presented. It was noted that many of the compounds fulfilling the structural requirements for radiosensitizing ability on the basis of the Adams hypothesis were inactive; no discernible correlation between sensitizing activity and molecular structure could be found. Sensitizing ability was correlated more strongly with the capacity for reaction with SH groups than with the presence of carbonyl groups incorporated in a resonating system. (H.L.W.)

Radiation Sickness and Injuries

Refer also to abstract 38595.

38630 MAXILLOFACIAL PROSTHETIC REHABILITATION OF POSTOPERATIVE CANCER PATIENTS. Riley, Cordell (Univ. of California, Los Angeles). J. Prosth. Dent., 20: 352-60(Oct. 1968).

Preparation and use of maxillofacial prosthetics in patients subjected to surgery and irradiation are considered. The prosthodontist can be of great assistance to radiotherapists in devising appliances to aid and afford protection in radiotherapy. Some of these aids include: shields to deflect the tongue from the field of irradiation; carriers to position Ra needles; cone locators to position the cone over the lesion; and follow-up treatment and postirradiation dentures. Before a denture can be made, the patient is evaluated as to type and dose of irradiation, location and type of lesion, and the presence of oral lesions as a result of the irradiation. For most patients, a 1-yr waiting period should be allowed before the construction of dentures. The denture base over the irradiated region should be lined with a soft vinyl or silicone in order to minimize trauma. Postirradiation necrosis or destruction of the dental tissues may occur in over 40% of the patients treated for oral lesions. (BBB)

38631 THE FREE COMPOUND FLAP GRAFT USED AFTER X-RAY-DAMAGED FACIAL TUMORS. Drepper, H. (Klinik Haus Hornheide, Handorf, Ger.). Hautarzt, 19: 132-5(Mar. 1968). (In German).

The use of the compound flap graft for the repair of skin injuries induced following treatment of facial skin tumors with doses of about 5000 to 12000 R x radiation is described and discussed. The surgical operational techniques are illustrated by several cases of recurrent basilioma terebrans. Preparation of the skin area to be grafted, time intervals between procedures, and precautions necessary to ensure adequate vascularization and wound healing are described. One distinct advantage of this graft procedure is that fast electrons or close-up ^{60}Co irradiation can be administered as soon as two or three weeks after healing. The advantages of the compound flap graft over pedicle grafts for repair of irradiation damaged facial tissues are discussed. (BBB)

38632 SPONTANEOUS HEMATOPOIETIC RECOVERY OF FRIEND VIRUS-INFECTED MICE AFTER HEAVY X IRRADIATION. Gallien-Lartigue, O.; Tambourin, P.; Wendling, F.; Zajdela, F. (Faculte des Sciences, Orsay, France). J. Nat. Cancer Inst., 42: 1061-7(June 1969).

Endogenous hematopoietic recovery, after exposure to 950 R of whole-body x radiation, was obtained in Swiss mice made splenomegalic (800 to 2000 mg) by inoculation of anemia-producing Friend virus (FVA) 15 days prior to irradiation. Mice infected 6 days before, whose spleen weight did not exceed 300 mg, showed no hematopoietic recovery and died within the same interval as their controls. This finding seems to indicate that the stem-cell pool still available after exposure to 950 R was considerably increased in splenomegalic, FVA-infected mice. Clusters of precursors of granulocytes, platelets, and sometimes erythrocytes were observed in spleen sections as early as 3 days after irradiation. No strict correlation was found between presence of surface spleen nodules and survival, which did not exceed 40%. Unrestrained proliferation of reticulum cells was resumed the second week after irradiation. Survivors demonstrated an increased lifespan as compared with unirradiated mice that had been virus-inoculated at the same time. (auth)

38633 A NEW POSSIBILITY FOR THE TREATMENT OF EXUDATIVE RADIODERMATITIS OF THE SKIN. Stiglbauer, Rudolf. Wien. Med. Wochenschr., 117: 847-9(Sept. 16, 1967). (In German).

Methods of prevention and treatment of exudative radiodermatitis were discussed. To prevent radiodermatitis the possibility was discussed of using irradiation fractionation, sieve irradiation, various types of moving irradiation, and high-energy irradiation in treatment of precancerous skin diseases and carcinomas. It was emphasized that because the skin lesions to be irradiated were located in the skin itself, irradiation of deeper layers was unnecessary, and also could impair regeneration of the areas treated.

The use of oxyphenylbutazone (Tanderil) for treatment of exudative radiodermatitis was recommended. The procedure suggested to reduce incidence and improve treatment of radiodermatitis was outlined. It consisted of fractionated irradiation treatment accompanied by concurrent treatment with Tanderil. This combined treatment resulted in preventing or reducing the intensity of the radiodermatitis in the cases reported, without evidence of side effects. (BBB)

Radiodiagnosis

Refer also to abstracts 38239, 38256, 38262, 38263, 38271, 38289, 38290, 38292, 38293, 38360, 38451, 38573, 38580, 38584, 38599, 38605, 38826, 38847, 38849, 38861, and 38878.

38634 DIAGNOSIS OF AORTIC ANEURYSM WITH RADIONUCLIDE ANGIOGRAPHY. Freeman, Leonard M.; Mindelzun, Robert (Yeshiva Univ., Bronx, N. Y.). Amer. J. Surg., 116: 433-6(Sept. 1968).

The detection of aortic aneurysms by serial scanning with ^{99m}Tc and γ scintillation camera is described and discussed. (BBB)

38635 FUNDAMENTAL PHYSICS OF RADIOLOGY. Meredith, W. J.; Massey, J. B. Bristol, Eng., John Wright, 1968. 607p. 90s.

The subject is treated under the following headings: General Physics — matter and energy; radiation and spectra; atoms and nuclei; radioactivity; radioactivity-materials; production of x rays; interaction of x and gamma rays with matter; effects of x rays; measurement of x ray quantity; the Roentgen and its measurement; Geiger–Mueller and scintillation counters; absorbed dose and the rad; and filters and filtration. Diagnostic Radiology — physical basis; the x-ray film and its processing; properties of the x ray film; intensifying and fluorescent screens; geometric factors influencing the radiographic image; effect of x-ray absorption on the radiographic image; effects and control of scattered radiation; the radiographic exposure; the diagnostic x-ray tube and shield; electrical circuits of x-ray unit; rating of x-ray tube; fluoroscopy; tomography. Radiotherapy — physical principles; teletherapy dosage data–general considerations and data for clinical use; output measurements and use of isodose charts; patient dosage; beam modification; collimators and beam direction devices; special techniques and alternative radiations; teletherapy sources; acceptance tests and calibration; radium and radon sources for plesiotherapy; plesiotherapy dosage calculations and alternative gamma-ray sources; and radioactive isotopes in clinical medicine. Radiation Protection — general principles and materials; departmental protection; and protection instruments and personnel monitoring. (UK)

38636 SCINTILLATION SCANNING IN A COMMUNITY HOSPITAL: A REVIEW. Kay, Chester (Park City Hospital, Bridgeport, Conn.). Conn. Med., 33: 314-18(May 1969).

General principles, procedures employed, and results of brain scanning with ^{99m}Tc-pertechnetate are presented. With ^{99m}Tc, a short-lived radionuclide which emits a low-energy γ ray, higher doses of radioisotope can be administered to the patient with a lower whole-body radiation dose. The higher count rate has many advantages. It can be utilized to do more views, and scans can be performed more rapidly. Technetium-^{99m} can be eluted from a generator daily. Its short 6-hr physical half-life and use of larger doses result in higher count rates over the calvarium. Scan speeds can thus be increased permitting more rapid evaluation. The whole-body dose from 10 mCi of ^{99m}Tc-pertechnetate is 100 mR. The mechanism by which the radionuclide is concentrated in a brain lesion is not clear. Breakdown of the blood-brain barrier occurs but the site or sites of localization of the isotope have not yet been defined. The author generally starts scanning the patient one-half hr after the intravenous injection of ^{99m}Tc. Technetium-^{99m} may also be given orally in which case the scan is started at 1 hr. Earlier scans may be useful when a vascular malformation is being considered, and delayed scans helpful where metastatic tumors or other suspicious areas of pathology are suspected on initial views. Subdural and epidural hematomas may be seen to better advantage on delayed studies where the count rate of the normal vascular rim has decreased and more isotope has accumulated in the lesion itself. Clinical results are described and illustrated. (BBB)

38637 APPLICATION OF RADIOISOTOPES IN UROLOGICAL DIAGNOSIS. Oester, Arne; MacKinney, Archie; Madsen, Paul O. (Veterans Administration Hospital, Madison, Wis.). Urologe, 7: 138-42(1968). (In German).

Quantitative methods for testing kidney functions by means of radioisotopes are described and discussed. These include measurement of glomerular filtration with inulin labeled with ^{131}I or ^{51}Cr, by allylinulin labeled with ^{125}I, or by ^{58}Co-labeled vitamin B_{12}, ^{131}I-labeled meglumine-diatriazoate, or ^{131}I-labeled Na iothalamate, estimation of renal blood flow by ^{131}I- labeled hippurate, or ^{131}I-labeled iodopyracet, and qualitative kidney function tests, such as the nephrogram. Kidney scintigraphy with ^{203}Hg-labeled chlormerodrin, and other similar, labeled compounds is described and its advantages for study of kidney function and diagnosis are outlined. (BBB)

38638 CHOICE OF ISOTOPE FOR THYROID SCANNING. Charkes, N. David (Temple Univ., Philadelphia). J. Nucl. Med., 9: 504-5(Sept. 1968).

Results using ^{125}I for scanning the thyroid gland are compared with results using ^{131}I or ^{99}Tc-pertechnetate. It was concluded that best results are obtained using ^{125}I and collimators designed for use with scintillation detectors for counting the low-energy x radiation emitted by ^{125}I. (C.H.)

38639 SCINTILLATION SCANNING OF MALIGNANT MELANOMAS WITH RADIOIODINATED QUINOLINE DERIVATIVES. Beierwaltes, William H.; Varma, Vijay M.; Counsell, Raymond E.; Lieberman, Lionel M. (Univ. of Michigan, Ann Arbor). J. Nucl. Med., 9: 489-91(Sept. 1968).

A number of ^{125}I-labeled analogs of chloroquine were found to concentrate in the melanin of eyes and skin of black mice. Radioactivity from ^{125}I-labeled-4-(3-dimethylaminopropylamino)-7-iodoquinoline was found to concentrate in malignant melanomas of Syrian hamsters in sufficient amounts to produce good scintillation scans. (C.H.)

38640 PLACENTAL LOCALIZATION BY INHALATION OF RADIOACTIVE CARBON MONOXIDE. Glass, H. I.; Jacoby, J.; Westerman, B.; Clark, J. C.; Arnot, R. N.; Dixon, H. G. (Hammersmith Hospital, London). J. Nucl. Med., 9: 468-70(Sept. 1968).

With the availability of small isotope-producing cyclotrons, the use of ^{11}C-monoxide for the localization of the placenta may well have wide application. The combination of low radiation dose, complete absence of handling and labeling problems, and the atraumic administration by 30-sec inhalation makes it an attractive alternative to other substances previously used for placental localization. (auth)

38641 LUNG IMAGING WITH THE PINHOLE ANGER CAMERA. Quinlan, M. F.; Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore). J. Nucl. Med., 9: 497-8(Sept. 1968).

Use of the pinhole Anger camera allows simultaneous, rapid, and satisfactory imaging of the lungs when particles labeled with a millicurie dose of a short-lived radionuclide are used. The pinhole collimator affords flexibility in field size unlike the multihole collimator which restricts the area of the field of view to that of the crystal. Examples using particles or microspheres labeled with ^{113}In or ^{99}Tc are reported. (C.H.)

38642 EXPERIMENTAL AND CLINICAL OBSERVATIONS ON THE NATURAL HISTORY OF PULMONARY EMBOLISM. Sabiston, David C. Jr.; Wolfe, Walter G. (Duke Univ. Medical Center, Durham, N. C.). Ann. Surg., 168: 1-15(July 1968).

With the use of large, autologous thrombi formed in vivo in dogs and subsequently passed into the pulmonary arterial circulation, the natural history of pulmonary embolism was studied. Following embolization, senal chest films, pulmonary arteriograms, and lung scans using ^{131}I-human serum albumin were evaluated. An accurate and objective diagnosis of pulmonary embolism was made by arteriography and lung scanning. The perfusion scan returned to normal in approximately 1 month. Pathologic examination revealed progressive resolution of the emboli with only residual material remaining at 10 weeks. The two chief reactions to embolic occlusion of the pulmonary artery are the formation of new channels between the embolus and the pulmonary artery and the removal of foreign material by intravascular thrombolysis. Ultimately, the embolus disappeared or remained as a collagenous scar on the wall of the pulmonary artery. Thus, the natural history of pulmonary embolism is frequently one of progressive resolution with return of pulmonary blood flow through previously occluded arteries. These conclusions were drawn from studies in the experimental animal and clinical observations in man. (auth)

38643 CISTERNAL BRAIN SCANNING WITH POSITRON-EMITTING ISOTOPES. McQueen, J. Donald; Abbassioun, Kazem (Baltimore City Hospitals). J. Neurosurg., 29: 597-602(Dec. 1968).

Experience with intraspinal injections of 2 positron-emitters,

^{74}As and ^{68}Ga, is presented to emphasize the value of cisternal scanning in children, the safety of ^{68}Ga as a scanning agent, and to note the unusual observations with ^{74}As as compared with those described previously after intrathecal injections of other materials (^{198}Au, radioiodinated albumin, pertechnetate). The sodium arsenate ^{74}As was injected in the lumbar region with a dose of 75 μCi in infants and 750 μCi in adults. The doses of ^{68}Ga were 500 μCi for children and 2 mCi for adults. Because of the very short half-life of 68 min, these doses gave low total-body irradiations of 15 to 50 mrad. All scans were carried out with a positron scanner. In the described technique of brain scanning with positron-emitting isotopes, ^{68}Ga was preferred because of the radiation safety factor. In children the basal cisterns were shown very quickly following injections of small amounts of either material. The initial isotopic deposits were in the cisterns of the posterior fossa. Maximal activity occurred about 1 hr after passage of the radioactive material through the tentorial notch. The ^{74}As pattern was unlike that described previously in that there was prolonged retention in the basal cisterns. (BBB)

38644 PLACENTAL LOCALIZATION: THE USE OF ^{99m}TECHNETIUM ALBUMIN AND THE SCINTILLATION CAMERA. Loken, Merle K.; Dunham, Charles; Spellacy, William H. (Univ. of Minnesota Hospitals, Minneapolis). Minnesota Med., 51: 907-10 (July 1968).

The use of ^{99m}Tc-labeled serum albumin and a scintillation camera for localization of the placenta is described, as well as a study of the fetal transfer of radioactivity and thereby assessment of the radiation hazard of the procedure. In 10 subjects venous blood was serially obtained for two hr following ^{99m}Tc-serum albumin administration and also at the time of delivery. Umbilical cord blood and amniotic fluid were also obtained. External counts were made on some infants following delivery within three hr of the time of maternal administration of the radioisotope. In no case was there significant radioactivity found in the infants. These data indicated that essentially no radioactivity crosses the placental barrier. In one infant, cord blood was found to show some radioactivity (17% of maternal blood counts per ml), indicating that not all of the administered ^{99m}Tc was labeled to the albumin. The radiation dose to the mother and the fetus appeared to be well within acceptable limits, irradiation being considerably below that which would be received by conventional radiographic techniques for evaluation of the placental location. (BBB)

38645 RAPID SEQUENTIAL KIDNEY SCANNING WITH ^{131}I-HIPPURAN. Lubin, E.; Levitus, Z.; Shimeoni, A. (Tel-Aviv Univ., Israel). J. Nucl. Med., 9: 567-70(Nov. 1968).

The dynamics of hippuran in the kidneys were studied by rapid sequential scanning performed with a conventional scanner. This method proved especially useful in the interpretation of the causes in anuria in transplanted kidneys, the early recognition of intra-abdominal urinary fistula, and the recognition of localized partial ischemia of the kidneys. (auth)

38646 SCINTIGRAPHY OF THE SKELETON USING ^{85}Sr. Malaspina, A.; Cardinali, P.; Castagnetti, G. L. (Istituto Radiologico dell'Ospedale Maggiore, Novara, Italy). Radiobiol. Radioter. Fis. Med., 23: 331-50(Sept.-Dec. 1968). (In Italian).

An extensive review is presented of the current literature on bone scanning with ^{85}Sr. The importance of scanning in the evaluation of patients with bone metastasis is discussed. It is pointed out that results obtained with this technique must be carefully interpreted in consideration of the possibility of false positive or negative responses. (auth)

38647 THE ARTICULAR SCAN IN PATIENTS WITH RHEUMATOID ARTHRITIS: A POSSIBLE METHOD OF QUANTITATING JOINT INFLAMMATION USING RADIOTECHNETIUM. Whaley, K.; Pack, A. I.; Boyle, J. A.; Dick, W. C.; Downie, W. W.; Buchanan, W. W.; Gillespie, F. C. (Centre for Rheumatic Diseases, Glasgow). Clin. Sci., 35: 547-52(Dec. 1968).

In view of the need for a sensitive method for detecting synovial tissue, and attempting to show the presence of abnormalities in the synovial membrane which occur in rheumatoid arthritis, the use of ^{99m}Tc was evaluated. If it were possible to demonstrate the existence of inflammatory and hypertrophic change in the synovium the early diagnosis of inflammatory joint disease might in some instances be facilitated. To obtain an objective index of articular inflammation, radioscans were performed on various joints in 24 patients with rheumatoid arthritis of varying severity, 25 min after the intravenous administration of 1 mCi of ^{99m}Tc. Localization of the isotope in the joint was easily demonstrated using a Picker Magnascanner V. Four hours before scanning each subject received 600 mg of potassium perchlorate orally, to block the uptake of ^{99m}Tc by the thyroid gland and the stomach. The dose of 1 mCi of ^{99m}Tc-pertechnetate gave a total-body exposure of 17 mRad. It proved possible to quantitate the display of the isotope in the joint. The method was sufficiently reproducible for clinical use, and the uptake was found to be a function of the clinical severity of joint inflammation. Further studies showed that the isotope is not actively concentrated by the diseased synovial membrane, and this finding suggests that the display of isotope in inflammed joints may reflect enhanced vascularity of the synovial membrane and other joint tissues. (BBB)

38648 GASTRIC BLOOD FLOW MEASUREMENT BY TECHNETIUM CLEARANCE TECHNIC: AN EVALUATION. Meredith, Jesse H.; Khan, Jamal (Bowman Gray School of Medicine, Winston-Salem, N. C.). Amer. Surg., 33: 969-72(Dec. 1967).

The possibility of using the clearance of ^{99m}Tc by the stomach obtained by measuring the gradient of radioactivity between the arterial and gastric venous flow for indirect quantitative estimation of gastric blood flow was studied in dogs. Gastric blood flow was measured directly by the electromagnetic blood flowmeter and calculated indirectly by ^{99m}Tc clearance. Accuracy of the ^{99m}Tc clearance method was demonstrated. The gastric clearance in a single animal remained consistent from one time to another. However, there was variation from animal to animal which may have been related to age, nutritional status, genetic background, and unknown disease. There was little or no difference with the other variables studied, such as histamine, time, or anesthesia. The feasibility of using ^{99m}Tc clearance for calculating gastric blood flow was demonstrated. (BBB)

38649 ISOTOPE SCANNING OF BRAIN TUMORS USING ^{99m}Tc. Filson, Edgar J.; Rodriguez-Antunez, Antonio (Cleveland Clinic Foundation). Acta Radiol., Diagn., 7: 380-4(Sept. 1968).

Biopsy-proved brain tumors were sought in 97 cases by scintigram after intravenous administration of 8 to 10 mCi of ^{99m}Tc-pertechnetate. An 8-in. crystal rectilinear scanner was used in 54 cases and a 3-in. retilinear scanner in 43 cases. Pertechnetate-^{99m}Tc appears to be an ideal agent for scanning because the short half-life (6 hr) permits a large amount of radioactive substance to be injected, while at the same time a small dose of radiation is received by the patient. This results in a high count rate. In the normal brain scintigram the calvaria is clearly outlined. Because the histochemical blood-brain barrier remains intact, the radioactivity is confined within the blood-vascular spaces of the dipole in the dural sinuses. The normal, relatively avascular, cerebral tissue stands out in sharp relief from the blood-vascular spaces. Meningiomas, even though slow-growing, concentrated radioactivity well because of their profuse vascularity and disruption of the blood-brain barrier. Less radioactive uptake was seen in slower growing or less vascular tumors, such as a grade I astrocytoma, but the uptake even by those tumors is usually sufficient for diagnosis. The statistics of scanning could be improved by the use of this isotope and an 8-in. crystal rectilinear scanner and thus make rapid linear brain scanning feasible. The overall diagnostic accuracy was 90% in this series. (BBB)

38650 FUNCTIONAL INVESTIGATIONS OF THE SPLEEN IN HEMOBLASTOSIS. Franke, W.-G.; Hennig, K.; Woller, P. (Medizinische Akademie, Dresden). Deut. Gesundheitsw., 24: 888-92(May 7, 1969). (In German).

On the basis of preferred intralienal storage of thermally alterated radiochromium-labeled erythrocytes already scintigraphically utilized, a method was developed for examining the storage function of the spleen RHS. By quoting examples of polycythemia, pathological and normal curves were demonstrated. One hundred forty-five patients were examined, 95 manifested hemoblastoses. The respective findings render sufficient evidence that the functional test, being combined with scintigraphy, yields information exceeding the diagnostic value of the individual method. (auth)

38651 RAPID SEQUENTIAL VISUALIZATION OF THE HEART AND GREAT VESSELS IN MAN USING THE WIDE-FIELD ANGER SCINTILLATION CAMERA: RADIOISOTOPE-ANGIOGRAPHY FOLLOWING THE INJECTION OF ^{99m}Tc. Mason, Dean T.; Ashburn, William L.; Harbert, John C.; Cohen, Lawrence Sanford; Braunwald, Eugene (National Heart Inst., Bethesda, Md.). Circulation, 39: 19-28(Jan. 1969).

The instantaneously sensing Anger scintillation camera, capable of recording wide-field radioisotope images from the precordium, and a system for video storage and analysis provided a means of visualizing the anatomic and hemodynamic features of the heart and great vessels without the hazards involved in introducing a radiopaque agent. Sodium pertechnetate labeled with ^{99}Tc ($^{99m}TcO_4^-$) was used as the tracer. (BBB)

38652 REGENERATION OF THE LIVER AFTER HEPATECTOMY. DeLand, Frank H.; Wagner, Henry N. Jr. (Johns Hop-

kins Medical Institutions, Baltimore). J. Nucl. Med., 9: 587-9 (Nov. 1968).

Liver scanning following the intravenous injection of ^{131}In colloids was used to provide objective evidence of the size and structure of the liver in patients following partial hepatectomy. (C.H.)

38653 SOME THOUGHTS ON LIVER SCANNING AS A FORM OF PARACLINICAL EXAMINATION. Marini, D. (Ospedale Civile Madonna del Popolo, Omegna, Italy). Minerva Med., 60: 189-96(Jan. 20, 1969). (In Italian).

The various types of tracers and the various methods used in liver scintiscanning are statistically examined and some typical scan features are discussed. It is concluded that this examination is not specific in the etiopathogenetic sense. It is, however, of undoubted value as an indispensable ally of conventional radiological techniques since it gives exact localization of neoplasms and is also of clinical and surgical importance. Scan pictures obtained in cirrhosis, secondary tumors, and in cases of deformity are described and the importance of various findings from the point of view of diagnosis is stressed. (auth)

38654 THE CLINICAL USE OF ORALLY ADMINISTERED ^{47}Ca FOR THE INVESTIGATION OF INTESTINAL CALCIUM ABSORPTION. Parsons, V.; Veall, N.; Butterfield, W. J. H. (Guy's Hospital Medical School, London). Calcified Tissue Res., 2: 83-92(July 1968).

A 15-μCi dose of ^{47}Ca was administered orally to patients with a variety of conditions associated with disordered Ca metabolism. The plasma specific activity and the urinary and fecal excretion of the tracer were measured and the results compared with data provided by metabolic balance studies. In 8 subjects where the carrier dose of Ca^{++} was 100 mg, the mean ^{47}Ca absorption was 32% of the dose (S.E.M. ± 2%, range 23 to 34%). In 7 subjects where the Ca^{++} carrier load was increased to 200 mg or more the mean absorption was reduced to 20% of the dose (S.E.M. ± 2.5%, range 15 to 28%). Simultaneous Ca balances allowed an estimate of Ca absorption to be made and this correlated with the blood and fecal data once an allowance was made for the endogenous secretion. This was found to be highly variable, mean values in the patients being 300 mg/24 hr. A slow type of intestinal absorption of ^{47}Ca was found in the osteoporotic group of patients. (BBB)

38655 SHORT-LIVED RADIOISOTOPES: AN OVERLOOKED FACTOR? King, E. Richard; O'Foghludha, Fearghus; (Medical Coll. of Virginia, Richmond). J. Nucl. Med., 9: 499-501(Sept. 1968).

The physical aspects of internal radiation dosimetry when radioisotopes with short half-lives are used for radioisotope scanning or clinical tracer studies are discussed. It is pointed out that a radiation dose delivered during a short period of time is more potent than an equal dose delivered over a longer period. It is suggested that the use of radioisotopes with short half-lives for clinical studies may not result in a reduction in the biological effects of radiation. (C.H.)

38656 SCINTIGRAPHIC ASPECTS OF THE KIDNEY IN ACUTE COMPLETE URETHERAL OBSTRUCTION OF VARIOUS LEVELS. Aglietti, L.; Macca, G.; Motta, M.; Musumeci, S.; Cotroneo, G. (Univ., Catania, Italy). Med. Nucl.-Radiobiol. Lat., 11: 269-75(1968). (In Italian).

A renal scintigraphic study was made of 12 dogs after completely tying off the juxtavascular tract and the ureter at the pieloureteral junction. In animals in which proximal tying off was practiced, five showed greater captation of the operated kidney compared with the other kidney, except in one case where there was no appreciable difference between the two kidneys. The captated surface on the operated side appeared wider and roughly rounded in shape. In four animals tying off the juxtavascular ureteral tract produced no modifications as shown scintigraphically. The remaining two showed a negligible increase in the scintigram. It was concluded that renal scintigraphy is useful for diagnosis of the seat of acute complete ureteral obstruction. (auth)

38657 PLACENTAL LOCALIZATION BY COLORSCAN USING ^{132}I-LABELED HUMAN SERUM ALBUMIN. Robertson, Euan G. (Princess Mary Maternity Hospital, Newcastle upon Tyne, Eng.); Millar, David G.; Day, Michael J. J. Obstet. Gynaecol. Brit. Commonwealth, 75: 636-41(June 1968).

Safety features; comparative doses to the thyroid, whole-body, and fetus; and excretion of radioactivity were considered in a study of ^{132}I-human serum albumin (IHSA) for placental localization. Use of ^{131}I may involve unnecessarily high radiation doses to the fetal thyroid gland, and ^{132}I is recommended, which has a half life of only 2.3 hr compared with 8.05 days for ^{131}I, its only disadvantage being the rather high energy of the γ radiation. The use of a more sensitive detector enables a smaller quantity of ^{132}I to be used rather than the usual 50 μCi. By modifying the technique of localization the reduction in dose need not be accompanied by decreased accuracy. A color scanning technique is described that gives an improved visual display of the information, and despite the smaller radiation dose it is more accurate than the usual method of radioisotopic localization. (BBB)

38658 PROBLEMS ASSOCIATED WITH RADIOLOGICAL MEDICATION. Ishihara, Junichi (Tokyo Women's Medical Coll.). Tokyo Joshi Ika Daigaku Zasshi, 39: No. 12, 83-92 (Feb. 1969). (In Japanese).

The importance of radiological medication in modern medicine is increasing day by day. On the other hand, there are some problems that must be deeply considered, pertaining to this development. The following topics, concerning the problem of iatrogenic complications, which is by all means one of the problems, are considered. On accidents caused by x-ray instruments, on radiographic techniques, on reading the radiograms, false interpretations, false analysis of the lesion, technical errors or insufficiency of material, after effect of opaque media, on the effects of radiation, genetically significant dose, leukemia significant dose, and radiation on pregnancy. (NSA of Japan)

38659 METHOD OF LYMPHOGRAMS AND LYMPHOGRAMS OF MINERS IN URANIUM MINES. Novakova, E.; Nosek, J.; Koskova, D. Vnitr. Lek., 14: 973-80(Sept. 1968). (In Czech).

A technique is described consisting of the differentiation of a fixed number of 100 lymphocytes according to some basic morphological characteristics of this type of cell. This technique was designated the lymphogram method. Lymphograms made in a group of controls were compared with the lymphograms obtained from uranium miners working underground. Lymphograms of miners displayed a greater number of large lymphocytes, lymphocytes containing azurophilic granules and lymphocytes with a vacuolized plasm. Lymphocytes of miners with a greater number of azurophilic granules also harbored—amongst the greater number of granules—more large, coarse granules. Further evaluation concerned the frequency of the characteristic under study in the group of controls and in the group of miners. A single finding was taken as sufficient evidence for assigning yes, negative findings were evaluated none. This evaluation revealed that the group of miners more frequently displayed one of the following signs in their lymphograms: vacuoles in the nucleus, Rieder type of lymphocyte nuclei, bare nuclei, vacuolized lymphocyte plasma, and coarse azurophilic plasma granules. (auth)

38660 OUR EXPERIENCES WITH ^{99m}Tc PLACENTOGRAPHY. Schmid, J.; Maroni, E.; Mueller, J. H.; Schreiner, W. E. (Univ., Zurich). Gynaecologia, 165: 113-15(1968). (In German).

The use of ^{99m}Tc for placentography was studied in 47 patients. Whole-body irradiation dose from 200 μCi of ^{99m}Tc used in placentography amounted to 1.6 mRad. Because ^{99m}Tc was bound to plasma albumin it was prevented from leaving the blood stream rapidly and did not pass through the placenta. Transfer to the fetus was minimal. The average amount of the dose found in the fetus and amniotic fluid was 5% of the activity measured in the mother. The localization of the placenta was correctly ascertained in 98% of the cases studied. (BBB)

38661 RADIATION QUALITY AND X-RAY EMULSION RESPONSES. Goren, Arthur D.; Pentel, Leon; Lluzzi, Anthony; Shapiro, Gerald; Goldfarb, Saul K. (New York Univ. Coll. of Dentistry, Yale Univ. School of Medicine, New Haven). Oral Surg., Oral. Med., Oral Pathol., 27: 467-74(Apr. 1969).

A quantitatively significant reduction in patient exposure can be achieved during dental radiography without significant alterations in image quality through the use of high-energy x radiation (3.0 mm aluminum HVL); high-speed film (ASA Class D); and rigidly observed time-temperature processing parameters. (auth)

38662 PULMONARY METASTASES FROM THYROID NEOPLASMS. Spreafico, G. L.; Ballarati, U. Med. Nucl.-Radiobiol. Lat., 11: 289-312(1968). (In Italian).

Eighty-nine patients with pulmonary metastasis were found among 345 thyroid cancerous patients. Some clinical statistical data were examined (frequency, age, sex and histological varieties) in relation to the patients with metastases, and afterwards a study was made on the site of the secondary thyreogenic localizations in the pulmonary region and on the diagnostic possibilities of scanning methods with ^{131}I. The results obtained using radioiodine in the treatment of iodine-fixing metastases were reported. (auth) (TSS)

38663 COMMENTS FROM THE AEC ON ^{197}Hg-CHLORMERODRIN. Buchanan, Cecil R. (Atomic Energy Commission, Washington, D. C.). J. Nucl. Med., 9: 502-3(Sept. 1968).

Data on the radiation dose and dose rate for the patient when ^{197}Hg-chlormerodrin or ^{203}Hg-chlormerodrin are used for scanning the brain and kidneys are presented. The decision of the AEC Advisory Committee on Medical Uses of Radioisotopes to discontinue approval for the use of ^{203}Hg in any situation where ^{197}Hg would be acceptable is discussed. (C.H.)

38664 SCINTIGRAPHY WITH ^{203}Hg AND ^{99m}Tc IN THE DIAGNOSIS OF BRAIN TUMORS. Schneider, C.; Prevot, H. Jr.; Tzonos, T. (Univ., Hamburg). Ger. Med. Mon., 13: 309-14(July 1968)).

The diagnostic effectiveness and relative radiation safety of two γ-emitting radioisotopes in detecting brain tumors in 514 patients are considered. The results showed that ^{203}Hg and ^{99m}Tc are eminently suitable for localizing of tumors of the brain. The typical findings in brain scanning are described, and the results obtained with the two radioisotopes in two large series of patients are compared. The site of the tumor can be more accurately determined with ^{99m}Tc than with ^{203}Hg. The chances of demonstrating a tumor, irrespective of its site and histological structure, are about the same for both (79% for ^{203}Hg, and 85% for ^{99m}Tc). However, in the diagnosis of gliomas of the cerebral hemispheres there was a difference; these tumors were demonstrated by ^{99m}Tc in 92% of cases and by ^{203}Hg in 81%. The kidneys receive a dose of about 160 rad from chlormerodrin labeled with ^{203}Hg. The introduction of ^{197}Hg-chlormerodrin has resulted in a reduction to $^{1}/_{10}$ in the radiation dose delivered to the body and ^{99m}Tc-pertechnetate is even safer since, after preliminary blocking of thyroid function, the radioisotope accumulates only in the intestine. The dose of one to two rad at this site is comparable to that of an x-ray study with a barium meal. (BBB)

38665 MEASUREMENT OF BLOOD VOLUME USING RED CELLS LABELED WITH RADIOACTIVE CARBON MONOXIDE. Glass, H. I.; Brant, A.; Clark, J. C.; de Garetta, A. C.; Day, L. G. (Hammersmith Hospital, London). J. Nucl. Med., 9: 571-5 (Nov. 1968).

The accuracy of blood volume measurements using ^{11}C–CO-labeled autologous erythrocytes or ^{51}Cr-labeled erythrocytes as tracers was compared. Results showed that measurements made with ^{11}C–CO were accurate when two blood samples were taken for analysis after allowing at least 10 min for the tracer to mix with blood in the body. The use of ^{11}C–CO results in a lower radiation dose to the patient and is especially desirable when measurements are made. Methods for the cyclotron production of ^{11}C by 15 MeV dueteron bombardment of boric oxide, reduction of $^{11}CO_2$ in the vessel to ^{11}CO, and for labeling erythrocytes with ^{11}CO are described. (C.H.)

38666 RADIOISOTOPE ANALYSIS OF IN VIVO HEMOLYSIS FOLLOWING INTRAVENOUS INJECTIONS. Wickliffe, Billie W.; Cadwallader, Donald E.; Ansel, Howard C. (Univ. of Georgia, Athens). Bull. Parenter. Drug. Ass., 22: 105-21(May-June 1968).

A method using ^{51}Cr is described that can be used to determine the amount of in vivo hemolysis caused by the intravenous injection of fluids of either small or large volumes. The ^{51}Cr-tagged red cells were injected into the test animals and the loss of tagged red cells from the circulating blood caused by the intravenous injection of the test fluid was determined by noting the decrease of cpm of washed red cell samples taken before and after the intravenous injections. The rabbit, body weight of 2.5 to 4.5 Kg, can be used as the test animal for in vivo studies of the hemolysis caused by the intravenous injection of Water for Injection. The rabbit tolerates large amounts of water when injected intravenously into its marginal ear vein. Experimental data, obtained by using this procedure, indicated that the rate of intravenous injections of water was not an influencing factor on the degree of in vivo hemolysis resulting. The volume of water injected was shown to affect the amount of in vivo hemolysis resulting when water was given intravenously. (BBB)

38667 CHANGES IN MINERALIZATION OF BONE AS DETERMINED BY X-RAY PICTURE AND SCINTIGRAM. Bessler, W. (Kantonsspitals, Winterthur, Ger.). Radiologe, 9: 154-62(May 1969). (In German).

The x-ray picure shows structure and density of bones due to their mineral content, while the scintigram reveals regions of increased bone metabolism. To evaluate skeletal changes, radiostrontium proves especially effective. For adult patients, strontium-85 is used; whereas, for children and adolescents strontium-87m is preferred because of its shorter half life and, therefore, its much lower whole-body dose. Localized bone lesions frequently can be detected earlier by scintigraphy than by x-ray pictures. (H.B.G.)

38668 AVERAGE BETA ENERGY, SPECIFIC γ-RAY CONSTANT, AND EQUILIBRIUM ABSORBED-DOSE CONSTANTS FOR ^{113m}In. Hendee, William R. (Univ. of Colorado, Denver). Phys. Med. Biol., 14: 491-4(July 1969).

The average "beta" energy $\bar{E}_\beta$ for this nuclide was calculated as 0.133 MeV/disintegration, about 15% higher than the value found in the literature. The specific γ-ray constant was 1.80 R/(hr-mCi) at 1 cm, in close agreement with the value reported previously. The equilibrium absorbed-dose constants Δ_i for photons from ^{113m}In are tabulated. (auth) (UK)

38669 USING DIGITAL-COMPUTER CIRCUITRY FOR MULTINUCLIDE SCANNING. Hisada, Kin-ichi; Hizume, Ichiro; Matsudaira, Masamichi (Kanazawa Univ., Japan). J. Nucl. Med., 9: 550-3(Nov. 1968).

Four-nuclide scanning was successfully performed with the Alderson Research Laboratory organ scanning phantom and four radionuclides, ^{198}Au, ^{203}Hg, ^{75}Se, and ^{197}Hg, all chosen with future clinical practice in mind. Isosensitive scanning, which can provide depth-independent information, is requisite for multinuclide scanning which aims at simultaneously visualizing multiple organs at various depths. Four scan-recording heads and four spectrometers are also indispensable parts of four-nuclide scanning. The pictorial quality of multinuclide scans was improved greatly by using digital-computer circuitry. (C.H.)

38670 PANCREAS SCANNING WITH ^{75}Se-SELENOMETHIONINE AND ^{198}Au USING DIGITAL-DATA-PROCESSING TECHNIQUES. Blanquet, P. C.; Beck, C. R.; Fleury, J.; Palais, C. J. (Hospital St. Andre, Bordeaux). J. Nucl. Med., 9: 486-8(Sept. 1968).

A dual tracer method is described for scanning the pancreas using an electronic subtraction technique for information provided by an Anger scintillation camera. After the usual preparation the subject receives 250 μCi ^{75}Se-selenomethionine injected intravenously. One-half hour later he is placed under the detector. The camera spectrometer is calibrated on the 270-keV peak of ^{75}Se using a 50-keV window. It appears preferable to begin the examination using selenium only so that no distortion occurs from the ^{198}Au Compton contribution. Detector pulses are stored positively and counting is stopped when the image on the volumetric display unit has sufficient density. Then 250 μC of ^{198}Au are injected intravenously. The spectrometer is now adjusted to count on the 408-keV peak, and information is stored negatively. During the second count the hepatic image progressively disappears and counting is terminated as soon as the pancreas is clearly separated from the liver. A Polaroid photograph can now be taken of the pancreatic image, producing a permanent recording for further diagnosis. Methods for electronic subtraction are described that use: dual analog-to-digital converter for digitally coding the x and γ amplitudes furnished by the camera; a data storage unit in which digital information may be classified and stored; a volumetric display unit that generates a wide variety of presentations of the memory contents of its own built-in oscilloscope; and a data processing unit that can record memory contents on magnetic tape. The data processing unit substracts memory contents accumulated during a given interval of time from those accumulated during another interval using preselected coefficients while maintaining spatial relations between the channels. (C.H.)

38671 SCINTIGRAPHY'S CONTRIBUTION TO THE DIAGNOSIS OF PULMONARY TUMOURS. Tarolo, G. L.; Riccardi, A. (Univ., Milan). Radiol. Med., 55: 552-67(June 1969). (In Italian).

A sample of 100 pulmonary scintigrams performed on patients suffering from mediastino-pulmonary neoplastic processes was examined. Except for eight cases of metastatic pulmonary foci and another eight of mediastinohilar lymphoblastomas, all the remaining patients were suffering from primitive pulmonary carcinoma. As regards primitive pulmonary carcinoma the following findings are stressed: very low incidence of false negatives; extension of the area of defective fixation all the greater the more the tumor site is central, with frequent cases of exclusion of the whole lung in hilar forms. Instead, with reference to the other two groups of patients, a high incidence of false negatives and complete absence of scintigraphic findings of exclusion of a whole lung were observed. After discussing these findings also in relation to differential diagnostic problems, the usefulness of the method as a supplement to radiological examinations, especially for an early diagnosis of central pulmonary tumors is discussed.

38672 A VIDEO SYSTEM FOR RECORDING DYNAMIC RADIOISOTOPE STUDIES WITH THE ANGER SCINTILLATION CAMERA. Ashburn, William L.; Harbert, John C.; Whitehouse, Wil-

lard C.; Mason, Dean T. (National Inst. of Health, Bethesda, Md.). J. Nucl. Med., 9: 554-61(Nov. 1968).

A method is described whereby random light flashes occurring on the oscilloscope cathode-ray tube of the Anger scintillation camera are recorded on video magnetic tape for subsequent replay and nondestructive manipulation of the original data. The system is used primarily for recording rapid dynamic radioisotope studies such as vascular time-flow measurements in which it is essential to minimize the deadtime between individual frames of information. An area-of-interest mode lets one choose separate regions of the television raster from which analog tracings of the changing counting rate within these regions are obtained. These areas of interest can be varied in size and electronically placed in any position over the image raster, allowing precise visual control of the region to be analyzed. Physiologic data (e.g., ECG) can be recorded simultaneously on the audio portion of the tape and, on replay, used to gate the video signal so that picture integration occurs only during selected portions of the physiologic cycle such as cardiac systole or diastole. Clinical applications of potential value are discussed. (auth)

38673 THYROIDOLYMPHOGRAPHY: A NEW TECHNIC FOR VISUALIZATION OF THE THYROID AND CERVICAL LYMPH NODES. Matoba, Naoya; Kikuchi, Tokuro (Tohoku Univ., Sendai). Radiology, 92: 339-42(Feb. 1969).

A new technic is described for visualizing the thyroid gland and cervical lymph nodes. Ten minutes after the percutaneous injection of Lipiodol Ultra-Fluid directly into the thyroid, the lobe on the side of injection is completely outlined, and 24 hr later its regional lymph nodes are visualized. The method, termed thyroidolymphography, may be applied in the diagnosis of pathological conditions of the thyroid and cervical lymph nodes. (auth)

38674 NEW METHOD FOR RADIOGRAPHIC VISUALIZATION OF THE BRONCHOPULMONARY LYMPHATIC SYSTEM. Seki, Yasuo; Haneda, Yoshiji; Neyazaki, Toshihiko; Suzuki, Chigashi (Tohoku Univ., Sendai). Radiology, 92: 335-8(Feb. 1969).

A newly devised injection needle is described for indirect bronchopulmonary lymphography in man. Successful visualization of these lymphatics was accomplished with the injection of oil-based media to the enlarged subcarinal lymph nodes. (auth)

38675 RADIONUCLIDES IN THE POSTOPERATIVE MANAGEMENT OF ORTHOTOPIC HUMAN ORGAN TRANSPLANTATION. Brown, Donald W.; Starzl, Thomas E. (Univ. of Colorado Medical Center, Denver. Veterans Administration Hospital, Denver). Contract AT(11-1)-1472. Radiology, 92: 373-6(Feb. 1969).

Nuclear medicine can play an important role in the postoperative management of patients subjected to orthotopic human organ transplantation. Changes in the radioisotope renogram and renal scan aid in evaluation of the function of transplanted kidneys have proved to be of limited value in assessing the etiology of impaired function. In transplanted livers, infarctions and abscesses can be demarcated, and the development of rejection demonstrated by the ^{99m}Tc-sulfide scan.

38676 PREPARATION OF ^{99}Tc-LABELED HUMAN SERUM ALBUMIN IN COLLOIDAL FORM FOR USE IN LIVER SCINTIGRAPHY. Kort, Walter (Staedtische Rudolf-Virchow-Krankenhauses, Berlin). Strahlentherapie, 137: 420-3(Apr. 1969). (In German).

The preparation of a ^{99m}Tc-labeled serum-albumin-colloid suitable for liver scanning is described in detail. (auth)

38677 SELECTIVE LOCALIZATION TO PANCREAS OF RADIOIODINATED PHENYLALANINE ANALOGUES. Ullberg, Sven; Blomquist, Lars (Royal Veterinary Coll., Stockholm). Acta Pharm. Suec., 5: 45-53(Feb. 1968).

Attempts were made to develop a radiodiagnostic pancreas scanning compound which could be labeled with radioiodine and be selectively taken up by the pancreas. In whole-body autoradiography investigations of various iodinated amino acid analogs labeled with ^{3}H or ^{125}I, two relatively simple phenylalanine derivatives were found to localize fairly selectively in the pancreas of mice. The uptake was most pronounced for 4-iodophenylalanine and somewhat less for 3,4-diiodophenylalanine. A third related compound, 3-hydroxy-4-iodophenylalanine, showed no such uptake but accumulated in the walls of large blood vessels. The substances are probably not incorporated into proteins, and are rapidly excreted from the body. Possible implications especially of 4-iodophenylalanine as a radiodiagnostic agent for pancreatic diseases are discussed. Of the compounds used as radiodiagnostic agents for external scintillation scanning of the pancreas, the only substance so far successfully used for such scintillation is ^{75}Se-selenomethionine. When compared to this amino acid analog, 4-iodophenylalanine and possibly 3,4-diiodophenylalanine have at least two advantages. One is the higher degree of specificity for the pancreas, and the other is the rapid elimination through the kidneys with a consequent smaller total irradiation dose for a given amount of administered radioactivity. (BBB)

38678 STEREOSCINTIPHOTOGRAPHY. Charkes, N. David; Somburanasin, Rocha (Temple Univ., Philadelphia). J. Nucl. Med., 9: 494-6(Sept. 1968).

A method is described for the visualization of radioisotope deposition in tissues three-dimensionally. A high-count scintiphoto is taken with a γ camera and, without moving the patient, the camera is tilted symmetrically to the other side of the plane and a second picture is taken for the same number of counts. The stereo-paired scintiphotos are viewed by reflected light in a stereoscope. Results are reported from studies of the method in phantoms and diagnostic studies of brain tumors using ^{99}Tc-pertechnetate, of hepatic metastases using ^{198}Au colloid, and of pulmonary emboli using ^{131}I-albumin macroaggregates. (C.H.)

38679 AN EVALUATION OF THE IMAGE-INTENSIFIER SCINTILLATION CAMERA WITH SOME COMPARISONS TO THE SINGLE CRYSTAL CAMERA. Freedman, Gerald S.; Goodwin, Paul N.; Johnson, Philip M.; Pierson, Richard N. Jr. (Presbyterian Hospital, New York. St. Luke's Hospital, New York). Radiology, 92: 21-9(Jan. 1969).

The newly available image-intensifier scintillation camera (Ter-Pogossian-Picker-Magnacamera) was evaluated and compared to the single crystal camera (Nuclear of Chicago—Pho/Gamma). Parameters measured were detection efficiency, field uniformity, resolution, linearity, and system response function. Under dynamic conditions, imaging speed, resolution and information display, storage, and recording were also evaluated. The relative advantages and disadvantages of both commercially available systems are presented and their performance for radioisotope scanning under comparable conditions is discussed. (C.H.)

38680 CEREBROSPINAL FLUID RHINORRHEA STUDIED WITH THE GAMMA SCINTILLATION CAMERA. Ashburn, William L.; Harbert, John C.; Briner, William H.; Di Chiro, Giovanni (National Inst. of Health, Bethesda, Md.). J. Nucl. Med., 9: 523-9(Oct. 1968).

The technique of radioisotope cisternography using ^{99}Tc-albumin and scintillation cameras is described in detail and examples of verified cerebrospinal fluid leaks are shown. Applications in the diagnosis of cerebrospinal fluid rhinorrhea are discussed. The paramount advantage of using the scintillation camera, aside from speed, is the ability to examine the patient in any position which will elicit the maximum flow of cerebrospinal fluid through the site of leak. This position is most often with the head bent forward which precludes lateral scanning with the currently available commercial rectilinear scanners. (C.H.)

38681 MODULATION TRANSFER AND SCINTILLATION LIMITATIONS IN GAMMA-RAY IMAGING. Keller, Eldon L.; Coltman, John W. (Westinghouse Research Labs., Pittsburgh). J. Nucl. Med., 9: 537-45(Oct. 1968).

The modulation-transfer and scintillation limitations in gamma-ray imaging and their effect on the limiting performance of a widely used γ scintillation camera are discussed. This particular formulation combines the interdependent factors of resolution and sensitivity through the system modulation transfer function and the fundamentals of image perception. It is very useful for gaining an understanding of those factors which limit the performance of a given system and for comparing systems. The analysis is perfectly general and can be applied to any gamma-ray imaging device. Care must be exercised, however, when intercomparing systems. For example, the collimation characteristics of focused collimators used with rectilinear scanners differ from those for parallel-hole multiaperture collimators used with cameras. This is so because, aside from sectional scanning, most systems present a two-dimensional image of a three-dimensional object. Other differences can arise from different display systems and are related to subjective interpretation by the examiners. This overall problem is discussed from the limiting or optimum performance standpoint by considering a series of optimized collimators. This ideal flexibility is not normally available to the clinician, since his scanning instrument may be equipped with only two or three collimators. Notwithstanding, the present analysis will yield a plot of ν (or R) as a function of σt for each system configuration which can help him to understand his system and the most efficient tradeoffs among resolution, activity, and integration time available to him. The concepts of modulation transfer function and scintillation limitations to image perception are relatively new to the isotope imaging area of nuclear medicine although they have been applied to x-ray radiography for many years. The recent analyses of Beck and Harper incorporate these concepts and

have the same qualitative features as the present formulation. The plots of R as a function of σt obtained from the present considerations represent a new and powerful aid for understanding gamma-ray imaging systems. (C.H.)

38682 REGIONAL PULMONARY BLOOD FLOW IN CYSTIC FIBROSIS. Gyepes, Michael T.; Bennett, Leslie R.; Hassakis, Patricia C. (Univ. of California, Los Angeles). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 106: 567-75(July 1969).

The distribution of pulmonary blood flow was studied in 18 children and young adults with cystic fibrosis by pulmonary perfusion scanning. In addition, 10 of these patients also had ventilation scannings. The perfusion and ventilation scans showed good correlation; underventilated areas were uniformly and persistently underperfused and vice versa. The physiologic significance of these results is discussed. Perfusion scannings are easy to perform, even in small children. In this series the perfusion scan appeared to be more sensitive than the chest roentgenogram in detecting the presence and extent of early pulmonary involvement. The potential applications of scanning techniques in cystic fibrosis are discussed. Pulmonary perfusion scanning promises to be a useful technique in the diagnosis and management of cystic fibrosis, provided that these initial results will be confirmed by further and more extensive studies. (auth)

38683 NEUTRON RADIOGRAPHY IN BIOLOGIC MEDIA: TECHNIQUES, OBSERVATIONS, AND IMPLICATIONS. Brown, Mark (Medical Coll. of Georgia, Augusta); Parks, Paul B. Contract AT(07-2)-1. Amer. J. Roentgenol., Radium Ther. Nucl. Med., 106: 472-85(July 1969).

Neutron radiographic techniques were studied to determine their applicability to the visualization of biologic structures. Conventional roentgenograms and low energy neutron radiographs of various biologic specimens were compared. The radiographic densities observed were noted to be significantly different. Bone was found to be radiolucent when using neutrons. Fat and muscle could not be differentiated; however, air contrasts were enhanced in the neutron studies. The use of heavy water and gaseous compounds to artificially induce tissue contrasts appears to be the most promising area of investigation in low energy neutron radiography. Should fast neutron radiographic techniques be developed, they should be more useful where air must be visualized in the presence of bone and soft tissue. Preliminary dosimetry suggests that patient dose will not in itself preclude the clinical use of neutron beams for diagnostic purposes. (auth)

38684 IN VIVO DETERMINATION OF CELL LOSS IN EXPERIMENTAL TUMORS WITH ^{125}I-DEOXYURIDINE. Porschen, Walter; Feinendegen, Ludwig (Kernforschungsanlage, Juelich, Ger.). Strahlentherapie, 137: 718-23(June 1969). (In German).

The tumor growth rate is the difference between the cellular multiplication and the cell-loss. In two experimental tumors, sarcoma 180 and Ehrlich carcinoma, the tumor volume was measured daily in order to determine the doubling time and the apparent growth rate. The determination of cell loss is done in vivo by application of ^{125}I-deoxyuridine which is specifically incorporated in DNA and only partially realized (5%) after breakdown of this DNA. The results show modifications of the absolute and specific tumor activity during the growth. A decrease in the absolute tumor activity represents a cell-loss. It accounts for 0.35%/hour in the sarcoma 180 and 0.53%/hour in the Ehrlich carcinoma. (auth)

38685 STUDY OF THE HEMODYNAMICS OF PATIENTS WITH MITRAL STENOSIS AND MITRAL INSUFFICIENCY USING THE RADIOCARDIOGRAPHIC METHOD. Solov'ev, V. V.; Zharov, E. I.; Arshakuni, R. O. Kardiologiia, 8: No. 3, 13-7(Mar. 1968). (In Russian).

With the aid of quantitative radiocardiography using radioiodine-labeled human serum albumin 100 patients suffering from mitral disease were studied. Subject to measurement were the cardiac output, stroke volume, blood volume, pulmonary blood volume, and the pulmonary circulation time were measured. In the whole group of patients with mitral disease a drop of the cardiac output, and an increase of the blood volume, the pulmonary blood volume, the pulmonary circulation time were found. The values of cardiac output in patients with mitral stenosis and mitral insufficiency do not essentially differ by the mean values. The blood volume was augmented in mitral stenosis to a significantly greater degree than in mitral insufficiency. At the same time extreme values of the main hemodynamic indices in both groups coincided. Radiocardiography is a valuable method for studying the circulation in patients suffering from mitral disease. (C.O.)

38686 RATE MEASUREMENT OF RISA UPTAKE BY BRAIN TUMORS AND THEIR VALUE FOR DIFFERENTIAL DIAGNOSIS. Hirschbiegel, Horst; Pemsel, Heinz Karl (Univ., Duesseldorf, Ger.). Strahlentherapie, 137: 530-9(May 1969). (In German).

Following the uptake of RISA in cerebral tumors, it was demonstrated that this evolution and particularly the time of maximal activity was characteristic for different types of tumors. This gives a supplementary indication in the diagnosis of the type of tumor. In the tumors originating from non cerebral tissues (as meningiomes and metastases) the maximum of activity is obtained much more rapidly than in typical cerebral tumors (gliomas). (auth)

38687 LOCALIZATION OF THE PLACENTA. Maynard, C. Douglas N. C. Med. J., 29: 215-16(May 1968).

The advantages and disadvantages of the use of human serum albumin (HSA) labeled with ^{131}I, ^{99m}Tc, or ^{51}Cr, and ^{51}Cr-labeled red blood cells for localization of the placenta are discussed. Radioisotope placentography is a simple procedure for the evaluation of third trimester bleeding, with an accuracy of ~95%, and an extremely low radiation exposure to the fetus as well as the mother. The major difficulty in localizing the placenta by this procedure is when the placenta is implanted posteriorly. The most commonly employed compound is ^{131}I-HSA. It has the advantage of an 8-day half-life, satisfactory energy for external detection, and availability in precalibrated sterile solutions. Its main disadvantage is that a small percentage of the ^{131}I will become dissociated from the albumin. HSA tagged with ^{99m}Tc is superior to ^{131}I-HSA because its 6-hr half life and lack of β emission reduce the radiation to the fetus. This permits the administration of a sufficient amount of the radiopharmaceutical to get a scan of good quality. Its energy of 140 KeV is excellent for scanning. The main disadvantage is that it must be compounded just prior to use, sterilized, and assayed. Probably the agent of choice for small hospitals performing a limited number of procedures is ^{51}CrHSA. It has a pure γ emission of 320 keV, its half life of 27.8 days allows extended storage, and it is commercially available in precalibrated, sterile solutions ready for immediate use. It can also be utilized in radioisotope placentography by tagging the patient's erythrocytes. This method has the same advantages as those with ^{51}Cr-HSA, but has the disadvantage of requiring more time and specially trained technicians to perform the procedure. (BBB)

38688 STABILIZER REACTION-FREE ^{99m}Tc-SULFUR SUSPENSION FOR LIVER, SPLEEN, AND BONE-MARROW SCANNING. Webber, Milo M.; Victery, Winona; Cragin, Michael D. (Univ. of California, Los Angeles). Radiology, 92: 170-2(Jan. 1969).

A ^{99m}Tc sulfur colloid preparation for liver, spleen, and bone-marrow scanning was utilized without using dextran as a stabilizer, as dextran has been linked to patient anaphylactoid reactions. The quality of preparation was judged by Millipore filtration to determine free technetium and by microscopic examination to determine size and particle number. Liver and bone marrow scans of rabbits showed good resolution. A non-allergenic stabilizer was sought because the amount of soluble pertechnetate increased upon standing several hours after preparation. Heat- and acid-treated human serum albumin was found to be satisfactory in prolonging the stability of the suspension. (auth)

38689 STUDY OF INSULIN SECRETION DURING ARGININE PERFUSION: COMPARISON OF SYMPATHOLYTIC EFFECTS IN NORMAL AND HYPERTHYROID SUBJECTS. Modigliani, E.; Strauch, G.; Delzant, G.; Gilbert-Dreyfus (Faculte de Medecine, Paris. Hopital de la Pitie, Paris). Rev. Fr. Etud. Clin. Biol., 14: 267-75(Mar. 1969). (In French).

Radioimmunoassay of plasma insulin levels was performed during 11 arginine infusion tests in nine patients with thyrotoxicosis. Insulin peak was lower than in 17 control subjects. Following propranolol and guanethidine, the glycemic and insulin response to arginine infusion was unchanged in control subjects. Insulin response was greater in hyperthyroid patients treated with guanethidin and it was unchanged after treatment with propranolol, although the glucose blood levels were slightly lower. Significance of these results is discussed in view of physiological interrelationship between thyroid hormones, catecholamines, and glucose metabolism. (auth)

38690 PLACENTOGRAPHY WITH SHORT-LIVED RADIONUCLIDES. I. COMPARATIVE STUDIES OF THE DISTRIBUTION OF ^{87m}Sr-, ^{99m}Tc-, AND ^{113m}In-LABELLED HUMAN SERUM ALBUMIN IN THE ORGANS OF RATS AND PREGNANT RABBITS. Maier-Borst, W.; Lorenz, W. J.; Heep, J.; Sinn, H.; Krauss, O.; Prpic, B.; Scheer, K. E. (Institut fuer Nuklearmedizin, Heidelberg. Univ., Heidelberg). Nucl.-Med., 8: 1-14(Apr. 15, 1969). (In German).

The distribution of ^{87m}Sr-, ^{99m}Tc- and ^{113m}In-labeled human

serum albumin in the organs of rats and pregnant rabbits was determined to find a compound suitable for placentography in humans. ^{99m}Tc-albumin served as reference compound. Preliminary experiments on rats indicated that ^{87m}Sr- and ^{113m}In-labeled human serum albumin are most suitable for placentography. Both compounds were administered to pregnant rabbits and the distribution of the radionuclides in the maternal and fetal organisms was determined. In the case of ^{87m}Sr-albumin, some accumulation of the radionuclide in the skeleton of the fetus was noticed, whereas with ^{113m}In-labeled albumin no diaplacental passage of the radionuclide was observed. When compared with ^{99m}Tc-labeled albumin, ^{113m}In labeled human serum albumin, because of its higher stability, appeared to be best suited for placentography. (auth)

38691 PLACENTOGRAPHY WITH SHORT-LIVED RADIONUCLIDES. II. LOCALIZATION OF THE PLACENTA WITH ^{113m}In-LABELLED HUMAN SERUM ALBUMIN. Scheer, K. E.; Heep, J.; Maier-Borst, W.; Lorenz, W. J.; Sinn, H.; Krauss, O. (Institut fuer Nuklearmedizin, Heidelberg. Univ., Heidelberg). Nucl.-Med., 8: 15-21(Apr. 15, 1969). (In German).

After prior animal experimentation, placentography with carrier free ^{113m}In-labeled human serum albumin was used in pregnant women before amniotomy or in patients with suspected placenta previa. 500 μCi corresponding to an indium mass of less than 0.1 ng were injected intravenously resulting in a radiation dose to the fetus of less than 10 mrad. Blocking of the maternal and fetal thyroid was unnecessary. The contours of a placenta previa were not distorted by activity in the urinary bladder. In 19 such studies the site of the placenta could be determined in all cases. In two patients the prolonged period for which the patients were required to maintain a recumbent position for a conventional scintiscan resulted in a vena cava compression syndrome. To avoid such complications a Nuclear-Chicago scintillation camera was used with a pin-hole collimator that allowed the whole abdominal region to be viewed. With the same activity injected the time required for obtaining the placental image could be reduced to 7 to 10 minutes. The diagnostic value of the camera scintiphotos was comparable to that of the conventional scintigrams. (auth)

38692 SIMULTANEOUS DETERMINATION OF LIVER BLOOD FLOW AND POLYGONAL CELL FUNCTION IN HEPATOBILIARY DISEASES. Blaha, V.; Kolinska, J.; Blahnikova, L.; Endrle, E.; Sousek, O.; Vyska, K. (Hospital Praha-Motol, Prague). Nucl.-Med., 8: 22-34(Apr. 15, 1969).

Values for the extraction fraction of ^{131}I-Rose Bengal in the liver (E. F.) as an index of the ability of the polygonal cells to extract a foreign dye from the blood passing through the liver in 457 patients with various types of liver damage and a group of controls were reported. These values were obtained by means of the colloidal ^{198}Au clearance and the ^{131}I-Rose Bengal clearance determined simultaneously. In comparison with the control group the average value of the E. F. was decreased in the group of infectious hepatitis (~12%), and in the group of secondary or primary cancer of the liver (~14%). An increase of the E. F. was observed in the group of fatty infiltration of the liver (~11%) and in the group of congestive heart failure (~13%). In the groups of chronic liver diseases with and without portal hypertension the average value of E. F. was almost the same as the value in the control group, but a great variation of individual values was noticed. The value of E. F. in these groups as well as in the group of infectious hepatitis was closely related to the activity of the liver disease. This may be important for deciding the therapy, especially from the viewpoint of a possible indication to perform portocaval anastomosis. (tr-auth)

38693 CLINICAL VALUE OF LIVER AND RENAL SCANNING IN ONCOLOGY. Kesse-Elia, M.; Gyftaki, E.; Mavrikakis, M.; Sfontouris, J.; Binopoulos, D. (Univ. of Athens, Alexandra Hospital, Athens). Nucl.-Med., 8: 35-45(Apr. 15, 1969).

Liver scans were performed in 188 patients with metastatic or primary liver tumor, echinococcus cysts or hydrops of the gallbladder. The photoscans were positive in 96.2% of the cases with primary tumors and in 40 out of 47 patients with expected metastatic liver tumors. Correct interpretation was made in 97.4% of the liver echinococcus cysts and in 50% of patients with gallbladder hydrops. Renal scans were performed in 35 patients and diagnosis was confirmed by surgery. Of the 35 patients 21 had tumors and 14 cysts. The scans were positive in 91.4%. (auth)

38694 APPLICATION OF RADIOELECTROCARDIOGRAPHY FOR EXERCISE TEST. Czaplicki, S. (Military Medical Academy, Warsaw). Pol. Med. J., 7: 832-8(1968).

Translated from Pol. Tyg. Lek., 22: No. 29(1967).

In 50 patients with possible coronary disease showing normal ECG tracings at rest the test of graded effort on a bicycle ergometer was done to obtain the so-called effort limit. The ECG tracings (CV^5 lead) were recorded using a Metretel 1500 radioelectrocardiograph every minute during the exercise and 1, 3, and 5 minutes after the exercise. In cases with persisting changes the record after exercise was prolonged up to 15 minutes. The test was positive in 24 cases. In 21 cases significant changes appeared during exercise. The investigations of the author show that this method of determination of effort tolerance is safe and objective. (auth)

38695 IODINE METABOLISM IN AUTONOMOUSLY HORMONE-PRODUCING THYROID ADENOMAS. Grebe, S. F. (Justus Liebig Univ., Giessen, Ger.). Nucl.-Med., 8: 89-94 (Apr. 15, 1969). (In German).

Throughout a period of ten years, 20,000 iodine-131 studies including thyroid scans were performed; among these 164 toxic adenomas were found. Of the adenomas, 156 were decompensated as indicated by an accelerated iodine turnover, a total iodine-131 serum content in excess of 0.27 per liter, and a PB iodine-131 higher than 0.2%. The remaining eight toxic adenomas were compensated and showed a depletion phenomenon of the hot spot within 48 hours after iodine-131 administration. These patients showed levels of total iodine-131 and PB iodine-131 in the serum below 0.27 and 0.2% respectively. It is concluded that these serum levels represent the borderline between physiological and pathological values. (H.B.G.)

38696 STUDIES OF ^{131}I KINETICS IN VARIOUS DISORDERS OF IODINE TURNOVER. Grebe, S. F. (Justus Liebig Univ., Giessen, Ger.). Nucl.-Med., 8: 61-74(Apr. 15, 1969). (In German).

Results obtained with the radioiodine two-phase test including determination of the PB ^{131}I in about 20,000 patients indicate that the determination of the PB ^{131}I is required for a complete evaluation of the iodine turnover. Iodine dynamics may be enhanced, normal, slowed down or absent, and the various disturbances of iodine turnover may be distinguished accordingly. The many causes of alterations in the dynamics of iodine demonstrate that the radioiodine two-phase test is insufficient to diagnose thyroid function and that several supplementary tests with other laboratory methods such as the determination of the PB ^{127}I or the BE ^{127}I and the T_3 test are required. (auth)

38697 THE ^{125}I-ROSE BENGAL TEST IN PEDIATRICS. Lueders, D. (Univ., Goettingen, Ger.). Nucl.-Med., 8: 46-60 (Apr. 15, 1969). (In German).

In the past the Rose Bengal liver function test was performed with the dye labeled with ^{131}I. Instead ^{125}I-Rose Bengal was used, which for several reasons, particularly the lower radiation dose, is preferable for use in pediatrics. The test is primarily employed in the differential diagnosis of obstructive jaundice in early infancy. Two different methods are available: external counting and measurement of excreta. Although the curves observed by external counting in patients with obstructive jaundice are quite different from those observed in normal subjects, they do not allow a precise diagnosis to be made. The excretion test is much more reliable: in patients with extrahepatic biliary atresia and similar diseases only about 5% of the injected dose appears in the stools within five days; if more than 10% are excreted, complete obstruction of the biliary ducts can be ruled out and surgery can almost always be avoided. There is no other method by which complete biliary obstruction can be ruled out with comparable reliability. The importance of separate collection of stools and urine is stressed. (auth)

38698 RADIONUCLIDE VISUALIZATION OF THE PLACENTA WITH THE GAMMA-RAY SCINTILLATION CAMERA. Rosenthall, L. (Montreal General Hospital, Quebec). Can. Med. Ass. J., 97: 212-7(July 29, 1967).

To visualize and localize the placental blood pool relative to the symphysis pubis, a technique employing technetium-99^m pertechnetate ($^{99m}TcO_4$) or strontium-87^m (^{87m}Sr) and the gamma-ray scintillation camera were used. Approximately eight minutes is required for frontal and lateral views. The absorbed fetal radiation dose is similar for pertechnetate as technetium-99^m-labeled albumin, and the time-consuming preparation needed with the latter is avoided. Slightly more exposure is received with strontium-87^m, but it is still less than radiography by a factor of at least 100. Fifty-two women were examined in the second and third trimesters of gestation. When the placentas were localized by scan into categories of remote, low-lying, marginal, partial, or central placenta praevia, an accuracy of 95% was obtained. The results are 98% accurate when the categories are limited to remote, low-lying, and placenta praevia. The placental blood pool is clearly delineated and gross changes in perfusion may be detected. (Canada) (auth)

38699 THE INVESTIGATION OF BONE AND JOINT DISEASE USING ^{18}F. Jeremy, Ross; Cato, Jecelyn; Scott, B. W.; Morris, John (Royal Prince Alfred Hospital, Sydney). Med. J. Aust., 1: 492-7(Mar. 8, 1969).

In preliminary use of $Na^{18}F$ for bone scanning using a rectilinear scanner with standard collimator, 1 mCi intravenous doses were given to 42 patients, 32 with known or suspected disease. Of 12 with primary extraosseous malignant disease, nine showed scan evidence of bone involvement, including three cases where radiology was normal. Eleven with active peripheral arthritis showed abnormal scans. Four with suspected arthritic disease were normal. Five with other bone conditions showed increased uptake. ^{18}F is effective for detecting various bone and joint diseases but increased uptake is non-specific. Types of lesions cannot be differentiated. The most common application is detection of lesions before they cause abnormalities detectable by radiology. Scanning is sensitive in detecting arthritic activity but has little practical value in cases of active joint disease. In metastatic neoplastic disease a full skeletal survey should be made. (Australia)

Radiotherapy

Refer also to abstracts 38190, 38328, 38374, 38391, 38465, 38477, 38571, 38572, 38576, 38578, 38579, 38585, 38591–38594, 38617, 38662, 38748, 38826–38846, 38848, 38850, 38852, 38853, 38856–38859, 38862, 38866–38874, 38876, 38877, 39883, 39884, and 39886.

38700 HYDROXYUREA (NSC-32065) WITH IRRADIATION FOR CERVICAL CARCINOMA: PRELIMINARY REPORT. Hreshchyshyn, Myroslaw M. (Roswell Park Memorial Inst., Buffalo). Cancer Chemother. Rep., 52: 601-2(Sept. 1968).

The possible synergistic effect of hydroxyurea on radiation was examined in a double-blind study of 15 patients with advanced squamous cell carcinoma of the uterine cervix who were treated with radiation and hydroxyurea or radiation and placebo. Patients with the tumor confined to the pelvis received a 5000 to 6000 R dose of ^{60}Co γ irradiation over a period of four to six weeks complemented by intracavitary Ra γ for a combined total dose of 8500 R to the tumor. Patients with distant metastases received a 1300 to 4000 R tumor dose depending on the area of radiation and the patient's tolerance. The drug was given orally at the dose of 80 mg/Kg of body weight every 3rd day for 12 weeks. All patients who received hydroxyurea and none who received placebo had a temporary decrease of their white blood count to less than 3000/mm. Patients who completed radiation therapy maintained their blood count above that level. In patients with the tumor confined to the pelvis, none of the four patients who received placebo and three of the five who received hydroxyurea are alive and free of disease 12 to 16 months from the start of treatment. Thus, radiation combined with systemic administration of hydroxyurea was more effective than radiation alone. (BBB)

38701 CLINICAL STATISTICS OF 388 CASES C^{IV} EPITHELIOMA OF THE LIP TREATED WITH RADIOTHERAPY. Deplano, A. (Univ., Cagliari, Italy). Radiobiol. Radioter. Fis. Med., 23: 365-82(Sept.-Oct. 1968). (In Italian).

Clinical results are reported for 388 cases of epithelioma of the lip observed over a 10-year period. The patients were treated with contact x ray therapy (210); curie x ray therapy (170); electron beam therapy (5); surgical therapy (2); and ^{60}Co teletherapy (1). The total results included 260 recoveries and 17 deaths. It was impossible to get any information about 111 cases. The metastases were treated with electron beam therapy (12), with reduction (emptying) according to the Roux-Berger method (2); with ^{60}Co teletherapy (3), and with x ray therapy (3). The total results included two recoveries and six deaths. It was impossible to get information on 12 patients. On the whole the results were satisfactory, both as regards the early tumors and the metastases. (auth)

38702 PREOPERATIVE IRRADIATION AND CHEMOTHERAPY IN THE PREVENTION OF SURGICAL FAILURES: EXPERIMENTAL OBSERVATIONS ON AN ANIMAL TUMOR MODEL. Perez, Carlos A.; Olson, Judith (Washington Univ., St. Louis). Ann. Surg., 169: 584-91(Apr. 1969).

The value of preoperative x irradiation and several chemotherapeutic agents was evaluated in the prevention of surgical recurrences of a mouse lymphosarcoma. The administration of a small dose of one of four drugs and moderate doses of radiation was effective in greatly reducing the surgical failure rate. In addition, a significant delay in the appearance of the recurrent tumors was observed. It is suggested that a combination of integrated irradiation, chemotherapy, and surgical excision may be a rational approach in the management of cancer. (auth)

38703 PROGNOSTIC SIGNIFICANCE OF THE RELAPSE-FREE INTERVAL AFTER RADIOTHERAPY IN HODGKIN'S DISEASE. Kaplan, Henry S. (Stanford Univ. School of Medicine, Palo Alto, Calif.). Cancer, 22: 1131-6(Dec. 1968).

Data on the temporal distribution of initial relapses after radiotherapy in 296 cases of Hodgkin's disease were analyzed. Relapses were not randomly distributed; instead, they exhibited a pronounced clustering during the first 2 years, and the cumulative relapse curve reached a plateau by three to five years, indicating that the probability of developing an initial relapse later than five years after treatment must be quite small, almost certainly less than 5%. It follows that relapse-free five-year survivors have at least a 95% chance of being permanently cured. Relapse rates and relapse-free interval depend significantly on clinical stage and on the presence or absence of constitutional symptoms. After-survival of groups of one- and two-year survivors was strikingly better in those who were relapse-free during the interval than in those with one or more interval relapses. It is concluded that the cumulative relapse rate at three years represents a useful and valid early prognostic index. (auth)

38704 EPITHELIOMAS OF THE UTERINE CERVIX: TECHNIQUE AND RESULTS OF RADIOTHERAPY PARTICULARLY IN STAGE III. Rousseau, J.; Debertrand, Ph.; Mathieu, G.; Fenton, J. (Fondation Curie, Paris). J. Radiol., Electrol., Med. Nucl., 49: 643-9(Aug.-Sept. 1968). (In French).

The 1028 cases of cancer of the uterus treated at the Curie Foundation from 1956 to 1961 included 306 cases of stage III carcinomas (29.5%). These 306 cases were all treated by irradiation using external radiotherapy, associated or unassociated with a local application of radium. For the external radiotherapy, ^{60}Co was progressively substituted for x rays at 500 kV, which itself had replaced x rays at 200 kV. The prognosis of the stage III cancers of the uterine cervix was and remains grave. In this series the cure rate was 28% at 5 yrs; it falls to 19% after 10 years. Cobalt-60 therapy did not give superior results to those obtained using very penetrating x-ray therapy at 500 kV, which permitted the deep administration of high irradiation doses. The establishment of a uteral compression, shown by intravenous urography, obscured considerably the prognosis and the chances of a cure were then very slight (1 in 16). Few metastases were found; they were exceptional in the absence of local relapse. In the case of relapse it was the general practice to avoid all possible therapy. However, some isolated vaginal relapses benefited from a new local application of radium. The complications of radiotherapy were rare and generally were not severe. (tr-auth)

38705 PROTRACTED INTRA-ARTERIAL CHEMOTHERAPY WITH SEQUENTIAL COURSES OF ANTIMITOTICS AND RADIOTHERAPY IN THE TREATMENT OF EXTENDED HEAD AND NECK CANCER. Nervi, Carlo; Perrino, Annibale; Valente, Vincenzo; Cortese, Massimo (Instituto Regina Elena per lo Studio e la Cura dei Tumori, Rome). Tumori, 54: 199-219 (May-June 1968). (In Italian).

The possible synergistic effect of radiation on chemotherapeutic anticancer drugs was evaluated in 51 patients aged 20 to 78 yr with histologically confirmed cancer of the head and neck region. They were treated with sequential continuous arterial infusion of anticancer agents including 5-fluoro-2'-deoxyuridine and mitomycin C. At the end of the chemotherapy the patients were subjected to a full dose of external radiotherapy with the aim of destroying the residual cancer cells. Objective tumor regression was achieved in 27 patients lasting twice as long as in the same number of patients treated with external radiotherapy only. The study suggests that the concept of treating an extensive cancer with different drugs and therapeutic methods, used sequentially with the aim of destroying the greatest number of cancer cells, is valid. (BBB)

38706 EFFECT OF DIET UPON RADIATION RESPONSE IN CERVICAL CARCINOMA OF THE UTERUS: A PRELIMINARY REPORT. Cheraskin, E.; Ringsdorf, W. M. Jr.; Hutchins, K.; Setyaadmadja, A. T. S. H.; Wideman, G. L. (Univ. of Alabama Medical Center, Birmingham). Acta Cytol., 12: 433-8(Nov.-Dec. 1968).

The radiation response was studied in 54 female subjects with biopsy-proven squamous cell carcinoma of the uterine cervix, 27 of whom underwent nutritional therapy prior to irradiation; the remaining 27 served as controls. The radiation response was significantly higher following dietary changes than observed under control conditions. There was the suggestion of an inverse relation between clinical stage and the radiation response. However, the radiation response, following routine radiotherapeutic procedures, was quite variable, as seen by a mean and standard deviation of 63.3 ± 34.8% for the entire control sample. If 70% is

the delineation between a good and poor radiation response, the mean response for this group was poor. Only slightly over one-half of the control subjects showed desirable radiation responses according to conventional criteria. If it is assumed that there is a correlation between radiocurability and radiation response, then the experimental group should fare better both in terms of morbidity and mortality. The controls should, however, experience no better survival than has been reported for various populations. The subjects were instructed to consume more animal protein and were advised to eliminate sucrose and sucrose-rich products. All patients were given a multivitamin-mineral supplement and a vitamin C-water soluble bioflavonoid preparation. (BBB)

38707 INTRODUCTION TO RADIOTHERAPY OF CANCER OF THE UTERINE CERVIX IN STAGE III. Abbatucci, J. S. J. Radiol., Electrol., Med. Nucl., 49: 599-607(Aug.-Sept. 1968). (Inn French).

The anatomy and cytology of stage III carcinomas of the uterine cervix are reviewed in relation to their effect on the outcome of radiotherapy. The combined use of radium implants and fractionated doses of ^{60}Co γ with a total dose of 6,000 rads delivered to the pelvic region were found to give the best therapeutic results. (64 references.) (C.H.)

38708 COMPARISON BETWEEN THE RESULTS OBTAINED BY MEANS OF THE TRADITIONAL RADIOTHERAPY AND THE TELECOBALTOTHERAPY IN 77 CASES OF MALIGNANT TUMORS OF THE TONSIL. Venturoli, L.; Perri, G. (Univ., Pisa, Italy). Radiol. Med., 54: 792-804(Aug. 1968). (In Italian).

Results obtained in 77 cases of malignant tumors of the tonsil (epithelioma and sarcoma) are compared for conventional x and ^{60}Co γ teletherapy. The total survival after 3, 5, and 10 yr respectively was 28.3, 22.6, and 13.7%. Better results were obtained in the sarcomas and it was demonstrated that the most suitable treatment was telecobaltotherapy (50% recovery after 3 and 5 yr). (auth)(TSS)

38709 RADICAL RADIATION THERAPY AND TOTAL BODY IRRADIATION IN THE TREATMENT OF EWING'S SARCOMA. Millburn, Lowell F.; O'Grady, Lois; Hendrickson, Frank R. (Presbyterian-St. Luke's Hospital, Chicago). Cancer, 22: 919-25(Nov. 1968).

From 20th Annual Scientific Session of the James Ewing Society, Pasadena, Calif. See CONF-680460.

The results presented in the recent literature on the treatment of Ewing's sarcoma are more than encouraging. Radiation therapy has been and remains the treatment of choice in this disease. The concept of irradiating the entire bone of involvement with high doses in short periods of time has only recently been reached. The misinterpreted clinical observation that the rapid response of this tumor to ionizing radiation meant that it could be controlled by low doses has been slow to die. Many authors have advocated including the entire bone in the irradiated volume, yet no reported series states that this was done to all patients treated. In this article the authors present their experience with total-body radiation and Ewing's sarcoma in addition to the historical development of this treatment. Particular emphasis is placed on the radiotherapeutic approach to bone tumors and the feasibility of managing patients undergoing total body radiation of this magnitude. (auth)

38710 EPIDERMOID CARCINOMA OF THE PERIANAL SKIN AND ANAL CANAL. Kuehn, Paul G.; Eisenberg, Henry; Reed, John F. Cancer, 22: 932-8(Nov. 1968).

From 20th Annual Scientific Session of the James Ewing Society, Pasadena, Calif. See CONF-680460.

Cancer of the anus is a rare lesion. Two hundred cases registered in the Connecticut Tumor Registry are studied and treatment methods assessed. Therapeutic groin dissections are recommended for inguinal node metastases. The authors are now doing preliminary laparotomies to determine intra-abdominal spread of the disease prior to radical groin dissection. (auth)

38711 CARCINOMA OF THE PANCREAS. RESULTS OF TREATMENT. Gallitano, Alphonse; Fransen, Herbert; Martin, Richard G. (Univ. of Texas, Houston). Cancer, 22: 939-44 (Nov. 1968).

From 20th Annual Scientific Session of the James Ewing Society, Pasadena, Calif. See CONF-680460.

One hundred and thirty-four cases of carcinoma of the pancreas seen at The University of Texas M.D. Anderson Hospital and Tumor Institute at Houston between 1944 and through 1965 are reviewed. These cases are evaluated for survival and for relief of symptoms according to the modes of treatment. (auth)

38712 TREATMENT AND RESULTS OF RECURRENT CANCER OF CORPUS UTERI IN PATIENTS RECEIVING ANTERIOR AND TOTAL PELVIC EXENTERATION 1947–1963. Barber, Hugh R. K.; Brunschwig, Alexander (Memorial-James Ewing Hospitals, New York). Cancer, 22: 949-55(Nov. 1968).

From 20th Annual Scientific Session of the James Ewing Society, Pasadena, Calif. See CONF-680460.

In cases of cancer corpus uteri in New York state, 30% of these patients have recurrent or persistent disease. The authors question whether further therapy, in the form of exenteration, should be offered to these patients. Of 36 patients receiving pelvic exenteration 5 or more years ago, seven received their initial treatment less than 1 year prior to treatment for recurrence and none survived more than 15 months. Of the 29 patients who were free of disease for at least 1 year after initial treatment and before receiving exenteration for recurrence, five lived 5 or more years. It is concluded that there is a limited place for pelvic exenteration in the treatment of recurrent endometrial cancer. (auth)

38713 SURFACE MOULAGE TREATMENT TECHNIQUES UTILIZING ^{60}Co TELETHERAPY. A FOLLOW-UP STUDY. Schroeder, Alan F.; Scher, Allan J.; Brothers, William; George, F. W. (Naval Hospital, San Diego, Calif.). Cancer, 22: 968-72 (Nov. 1968).

From 20th Annual Scientific Session of the James Ewing Society, Pasadena, Calif. See CONF-680460.

Study of a method of treatment of carcinomas of the ear, nose, and penis that would provide no loss of function, and good cosmetic end results was undertaken at the Naval Hospital, San Diego, in 1957. Cobalt-60 teletherapy with a surface moulage of wax or acrylic resin was employed. The procedure is relatively simple and convenient, with ease of directing the therapy beam. There is increased homogeneity of dosage on irregular surfaces such as the nose, plus good clinical control of the lesions. During the past 5 years an increasing number of patients have been treated with the surface moulage-cobalt-60 teletherapy combination. Squamous cell carcinomas are treated with ten 450-rad treatments over a 12-day period, while basal cell carcinomas receive nine 450-rad treatments over an 11-day period. The striking features of this form of therapy are rapid healing and excellent cosmetic results. A 94% 1-year survival rate which is maintained through the fifth year was obtained. (auth)

38714 RENAL CELL CANCER IN THE SOLITARY OR SOLE-FUNCTIONING KIDNEY. Grabstald, Harry; Aviles, Enero (Memorial-James Ewing Hospitals, New York). Cancer, 22: 973-87(Nov. 1968).

From 20th Annual Scientific Session of the James Ewing Society, Pasadena, Calif. See CONF-680460.

This paper is a clinical review of 45 patients seen with renal cell cancer in solitary or sole-functioning kidneys. Of these, five have been managed at the author's institution. Relatively long time intervals have been noted between the diagnosis of the first cancer and the development of the second tumor. It is to be noted that the reason for removal of the opposite kidney was usually renal cell cancer. The possibility of metastasis rather than true primary is emphasized. The natural history of the disease is discussed, especially as it relates to a decision for therapy. Partial nephrectomy has been valuable in the management of the authors' and other cases. All survivals in the literature have had partial nephrectomy as a part of their therapy. (auth)

38715 PRIMARY RETICULUM CELL SARCOMA OF BONE. WITH EMPHASIS ON RADIATION THERAPY. Wang, C. C.; Fleischli, Donald J. (Harvard Medical School, Boston. Massachusetts General Hospital, Boston). Cancer, 22: 994-8(Nov. 1968).

From 20th Annual Scientific Session of the James Ewing Society, Pasadena, Calif. See CONF-680460.

A review of 21 patients with primary reticulum cell sarcoma of bone seen at the Massachusetts General Hospital is presented. Sixteen patients were treated by irradiation; ten survived without disease and of these six survived for 5 or more years. Five patients were treated by radical surgery; three survived without disease and two died with distant metastases. The combined 5-year cure rate, using radiation therapy and radical surgery, is 50%. Either radiation therapy or radical surgery can control the local disease. Since this tumor is known to possess moderate tendency to develop distant metastases and considerable radiosensitivity and radiocurability, the initial treatment of choice should be aggressive radiation therapy; radical surgery should be reserved as a back-up procedure to control persistent local disease. As a primary method of treatment, amputation is seldom advised. Under such a considered program, many limbs can be and have been saved and life usually and comfortably prolonged. (auth)

38716 INDICATIONS FOR AND RESULTS OF IRRADIATION OF CARCINOMA OF THE LUNG. Caldwell, William L.; Bagshaw, Malcolm A. (Stanford Univ. Medical Center, Palo Alto, Calif.). Cancer, 22: 999-1004(Nov. 1968).

From 20th Annual Scientific Session of the James Ewing Society, Pasadena, Calif. See CONF-680460.

In the majority of patients with pulmonary cancer seen in a radiotherapy department it is not possible to achieve more than short-term palliation. No pretreatment criteria allow the radiotherapist categorically to decide definitely which patients might be cured and which might receive palliation only. A number of clinical features—pain, weight loss of 10 pounds or more, supraclavicular metastases, hemoptysis, large mass requirement treatment fields of more than 200 cm^2, or history of resection longer than 6 months earlier—make long-term control unlikely, but some with these signs or symptoms may still be cured. Because one does not want to cause undue morbidity from high dose irradiation in incurable patients, a further attempt must be made to select the favorable cases from the group at large by careful evaluation during treatment. Split-course therapy is suggested as a means of refining this selection process since the rest period allows longer observation prior to commitment to a high dose. It is important that high dose therapy be offered to the favorable patients since as many as 5 to 8% of all referred patients can be cured and approximately 20% can be given long-term palliation. Satisfactory treatment results in the Stanford series were more frequent with doses in excess of 5500 rads in 6 weeks by conventional fractionation. (auth)

38717 ORAL RADIATION IN PROSTHODONTICS. Krajicek, Dayton D. (Veterans Administration Center, Wadsworth, Kan.). J. Amer. Dent. Ass., 78: 320-2(Feb. 1969).

Problems of interest to dentists in patients irradiated in the oral region, including development, prevention, and treatment of osteoradionecrosis, are considered. Experience confirmed that extraction of teeth in a previously irradiated area is a serious and dangerous procedure. Osteoradionecrosis can occur at any time, even as late as 10 yr after radiotherapy, and may lead to segmental resection of the mandible. It is unwise to try to save natural teeth at the expense of losing the jaw. Radiation in doses sufficient to be therapeutically effective for some oral tumors produces secondary chages that must be prevented whenever possible. Classification by the dental service of all patients before irradiation helps to avoid postradiation dental problems, particularly extractions. Should postradiation extraction of a tooth become necessary, the prophylactic use of tetracycline or Lincocin, instituted 24 hr before extraction and continued 5 days postoperatively, will tend to reduce the potential hazards which are always present. Strict oral hygiene must be maintained before and after extraction, and the surgery must be performed with a minimum of trauma, for osteoradionecrosis is the result of a triad-radiation, trauma, and infection. (BBB)

38718 TREATMENT OF CHRONIC LYMPHATIC LEUKEMIA BY EXTRACORPOREAL BLOOD IRRADIATION PERFORMED WITH CONVENTIONAL RADIOTHERAPY EQUIPMENT. Meuret, Gerhard; Schuetz, Walter; Harriss, Eileen B.; Fliedner, Theodor M.; Hoelzer, Dieter; Afkham, Jandux; Obrecht, Paul; Musshoff, Karl; Heinze, Volkmar; Tourkantonis, Achillis (Univ., Ulm, Ger. Univ., Freiburg i. B.). Strahlentherapie, 137: 429-41 (Apr. 1969). (In German).

A method is described for the treatment of chronic lymphocytic leukemia by extracorporeal irradiation of the blood, with conventional radiation sources. The treatment of three patients with chronic lymphocytic leukemia yielded partial remission in two with improved general condition, decreased leucocytosis and involution of the enlarged organs. The treatment had to be interrupted in the third patient, because of toxic effects (shivering and fever). These phenomena appear to be due to an increased catabolism of leukemic cells. The indication and mode of application, together with the basic principles of this new kind of treatment, is discussed. (auth)

38719 CANCER OF THE BREAST IN WOMEN. A RETROSPECTIVE CLINICAL STUDY OF 2416 CASES. Rissanen, Pentti M. (Univ. Central Hospital, Helsinki). Strahlentherapie, 137: 393-406(Apr. 1969).

Patients with carcinoma of the breast were studied. The material was distributed as follows on the basis of clinical staging according to the TNM-system: Stage I: 1066 cases (44.1%), Stage II: 486 cases (20.1%), Stage III: 772 cases (32.0%), Stage IV: 92 cases (3.8%). Conservative operative therapy combined with irradiation was the method frequently used for carcinomas of stage I. This combined therapy achieved approximately the same 5- and 10-year survival rate as radical surgery combined with radiotherapy. For all the cases of different stages combined, the 5-year survival rate was 57.5% and the 10-year rate 43.7%. It would seem on the basis of the study that conservative surgery combined with radiotherapy for carcinomas of stage I yields equally good 5-year and 10-year survival rates as radical operation, but complications seem to be considerably fewer in the conservation group. (auth)

38720 PERENDOSCOPIC IRIDIUM IRRADIATION OF THE LARYNX. Brandt, Rolf H. (Medizinische Akademie, Magdeburg, Ger.). Fortschr. Geb. Roentgenstr. Nuklearmed., 110: 880-5(June 1969). (In German).

A new method for the perendoscopic irradiation of early laryngeal carcinomas is described that uses an ^{192}Ir source of two to four Curies in a new gold applicator and a newly developed radiation protection device consisting of a special container and a cover for the patient's head and neck with a lead glass window. The endoscopic technique includes intravenous injection of barbiturates and muscle relaxants, with pure hyperbaric oxygen in order to increase the partial pressure of oxygen in the blood and tissues. Fractionated close irradiation of the tumor through direct endoscopic vision becomes possible as a form of after loading. (auth)

38721 PENDULAR IRRADIATION OF THE THORAX WALL FOLLOWING AMPUTATION OF THE BREAST AS CANCER TREATMENT. Schmidt-Hermes, Heinz Josef (Univ., Homburg, Ger.). Strahlentherapie, 137: 407-11(Apr. 1969). (In German).

The technique for obtaining the anatomical contour of a thorax and the method to determine the technical parameters for pendular irradiation with a Siemens 42 MeV betatron is described. The technical basis of the method is outlined and the different values derived from experimental measurements in a phantom are tabulated. It is shown that the problem of the field surface and of the depth dose can be solved in a relatively simple way for the 42 MeV betatron. The dose is homogeneous. (auth)

38722 HIGH-DOSE PREOPERATIVE IRRADIATION OF ESOPHAGEAL CANCER. Rodriguez-Antunez, Antonio; Groves, Laurence K. (Cleveland Clinic Foundation, Cleveland). Radiology, 92: 377-80(Feb. 1969).

Preoperative γ irradiation of esophageal cancer offers some theoretic advancement in control of tumors in the absence of distant metastasis at the time of surgery. The absence of such metastases is an assumption that every surgeon must make when performing a resection for cancer. Thinking along these lines, plans to continue the program in an effort to improve the effectiveness of local treatment are discussed. (auth)

38723 FIRST RESULTS OF RADIOTHERAPY OF BRONCHOPULMONARY TUMOURS WITH THE 42 MeV BETATRON. Coucourde, F.; Rovera, S.; Jucker, C.; Maestro, A. (Univ., Pavia, Italy). Radiol. Med., 55: 575-91(June 1969). (In Italian).

Results obtained with a 42 MeV betatron in a group of 141 patients suffering from malignant bronchopulmonary tumors are reported; both photon beams and electron beams of 42 MeV were used. The results were truly satisfactory and the authors emphasize the importance of using high energy betatrons for the treatment of malignant bronchopulmonary tumors, also in view of the slight side effects observed, especially when using electron beams. (auth)

38724 OUR EXPERIENCE OF TELECOBALTOTHERAPY IN INOPERABLE PULMONARY CARCINOMA. Felci, U. (Univ., Milan). Radiol. Med., 55: 568-74(June 1969). (In Italian).

A total of 306 patients suffering from inoperable pulmonary carcinoma have undergone telecobaltotherapy at the Institute of Radiology of the University and the Radiological Division of the National Cancer Institute, Milan, from 1959 to June 1965. The case-list is briefly analysed and the results are reported, expressed in survival terms: 36% were still surviving after 1 yr from the start of treatment; 13% after 2 yr; and 7% after 3 yr. The median survival period was little more than 8 months. The survival of patients whom it was possible to collect into two groups (those with differentiated epidermoidal or glandular form and those with histologically undifferentiated small or large cell form) was then examined; the source of the disease was less unfavorable for the first group. (auth)

38725 PREVENTION OF ABDOMINAL METASTASES AFTER INTRAPERITONEAL INJECTION OF YOSHIDA ASCITES CELLS: USE OF A NEW COLLOIDAL ^{32}P-CHROMIC PHOSPHATE. Anghileri, Leopoldo J.; Dogan, Erdal B. (Institut fuer Nuklearmedizin, Heidelberg). J. Nucl. Med., 9: 562-6(Nov. 1968).

Intraperitoneal injection of ^{32}P-labeled chromic phosphate colloids prevented the occurrence of abdominal cavity metastases induced by intraperitoneal injection of Yoshida ascites tumor cells in rats. Methods for the preparation of ^{32}P-labeled chromic phosphate colloids are described. (C.H.)

38726 A STUDY OF CENTRAL AND PERIPHERAL BIOPSIES IN COMBINED THERAPY OF HEAD AND NECK CANCER. Keim, W. Franklin; Koeck, George P.; Sarkisian, Sarkis S. Ann. Otol., Rhinol., Laryngol., 77: 508-13(June 1968).

Histologic studies were made of radiation effects in seven epidermoid carcinomas of the head and neck biopsied after successive doses of ^{60}Co γ radiation. Each lesion received a total of 3600 R over a period of 3.5 weeks. Radiation was given Monday through Friday in aliquots of 200 R. Identifiable tumor cells were found in most central and peripheral biopsies after 600, 1600, 2600, and 3600 R. In three of the surgical specimens of the primary tumor, identifiable tumor cells were found, while in the other two only an inflammatory reaction remained, consisting mostly of plasma cells with occasional multinucleated giant cells. At 3600 R and 10 days after completion of therapy neoplastic tissue was often difficult to find, but there was no consistent difference in the frequency of its occurrence in the center or in the periphery of the tumor. Mitotic activity, as evidenced by normal and abnormal mitoses, disappeared quickly after the initiation of radiation therapy, so that even after 600 to 1600 R dividing nuclei became difficult to find in both central and peripheral areas. Cytoplasmic vacuolization and nuclear swelling appeared early in the course of irradiation and became progressively more marked as fewer identifiable cells were found. Finally, the inflammatory stromal reaction, which replaced the tumor, consisted usually of plasma cells in a finely fibillar matrix of new connective tissue. Multinucleated giant cells, probably a foreign-body type responding to keratin, occurred regularly in the later stages of radiation reaction and repair. (BBB)

38727 EXPERIENCE WITH THE RADIOTHERAPY OF SYRINGOMYELIA. Gorbadei, N. K.; Skvirskaya, K. B. (Radiotherapy Section of the Central X-Ray-Radiological Inst., Moscow). Med. Radiol., 14: No. 5, 86-7(May 1969). (In Russian).

Two groups of patients each with 100 persons were treated for syringomyelia. The first group was given a single dose of 125 to 150 R with a total dose of 500 to 600 R in a series (corresponding to a dose of 336 to 403 rads to the site). The second group obtained a total dose of 900 to 1000 R with a dose of 605 to 672 rads to the site of infection. From clinical observations the patients in the second group were more severely afflicted than those in the first group. A decrease in subjective signs of the sickness, a decrease in pain, an increase in muscle tone, and improvement in general state served as criteria in estimating the effectiveness of the radiotherapy. The results of the therapy were almost the same in both groups. A more careful analysis of the data indicates that a dose of 300 to 400 rads to the site of infection in a series of irradiations can be considered as satisfactory for use. (TTT)

38728 MODIFICATION OF RENAL ALLOGRAFT REJECTION IN MAN. Carpenter, Charles B.; Merrill, John P. (Peter Bent Brigham Hospital, Boston). Arch. Intern. Med., 123: 501-13(May 1969).

Use of irradiation and other immunosuppressive agents in preventing human kidney transplant rejection is reviewed. Although whole-body irradiation treatment has devastating effects on the bone marrow and gastrointestinal tract as well as on lymphoid tissue, a more selective depletion of lymphocytes is possible by thoracic-duct cannulation and drainage, or by extracorporeal irradiation of the blood. Extracorporeal irradiation of the blood was performed in a limited number of patients prior to transplantation and in an even smaller number during rejection episodes. Depletion of whole-body levels of small lymphocytes by this procedure, as by thoracic-duct fistula, required several days of therapy, but was associated with no hazards to the patients who had arteriovenous shunts already in place for dialysis. When a single, centrally located γ-ray source, such as the ^{137}Cs irradiator, was used, the number of patients treated was limited, since 4 hr of therapy per day were needed. The use of small β-ray sources applied to the arteriovenous shunt, although difficult in terms of dosimetry, offered the advantage of treating large numbers of patients simultaneously. The preliminary results of extracorporeal irradiation have not suggested a dramatic improvement in survival as a result of lymphocyte depletion by this means, and these efforts were largely superseded by the use of heterologous antilymphocyte antibodies. Nevertheless, the condition of some patients with rejection episodes appears to have been improved by such therapy. (BBB)

38729 THE EFFECT OF IRRADIATION ON A MEDULLOBLASTOMA. Oppenheimer, D. R. (Radcliffe Infirmary, Oxford). J. Neurol., Neurosurg., Psychiat., 32: 94-8(Apr. 1969).

Histological comparison of a medulloblastoma before and after irradiation allowed radiation effects on the tumor to be delineated. The original tumor mass was surgically removed and the patient received radiation therapy. The whole brain, spinal cord, and cauda equina down to the level of the coccyx received 2700 R with 300-kV x rays. During this period the total dose to the posterior fossa was built up by means of supplementary fields to 3500 R by ^{60}Co γ rays. Sixteen months later a total of 2340 R was given, with ^{60}Co γ rays, to the whole brain but not to the spinal cord, using lateral opposing 27 cm × 12 cm fields. The course was not completed because of deterioration in the patient's condition and death. At autopsy the histological appearance of the irradiated tumor was quite different from the earlier specimens. The tumor was highly pleomorphic, being composed of irregular cells of all shapes and sizes, with numerous bizarre giant cells having giant or multiple nuclei. Many of them showed karyorrhexis, and were filled with coarse chromatin. In places the tumor was necrotic, and contained numerous swollen phagocytic cells; but the tumor vessels of all sizes appeared healthy, and there was no sign of thrombosis. There was no doubt that the histological change in the intracranial parts of the spreading tumor was due to the final course of radiotherapy. A cerebellar biopsy taken 5½ weeks before death showed a typical medulloblastoma, and identical tumor was found at necropsy around the spinal cord. The initial course of radiotherapy may have evoked a pleomorphic change, and the typical tissue found at necropsy was derived from cells that had escaped this radiation effect. It is possible that a curative dose of radiation was delivered to the cranial part of the tumor. (BBB)

38730 MALIGNANT MELANOMA: TREATMENT BY ENDOLYMPHATIC RADIOISOTOPE INFUSION. Edwards, J. M. (St. Thomas's Hospital, London). Ann. Roy. Coll. Surg. Engl., 44: 237-54(May 1969).

Studies in rabbits and humans on the effect of intralymphatic injection of a radioisotope were performed. Rabbits bearing lymph node metastases of VX2 tumor (resembling squamous cell carcinoma) were injected with ^{131}I-Lipiodol into the afferent popliteal lymphatics. The results of treatment were assessed on the basis of lymphadenogram appearance of the lymph nodes, macroscopic and microscopic findings at autopsy on the death of the animals, and survival times. In animals with metastases of 4 weeks the lymphadenograms showed that the nodes were heavily involved with tumor; large filling defects could be distinguished, implying uneven distribution of the isotope. As the maximum range of the β particle of ^{131}I is 2 mm in tissue with a mean range of 0.3 mm, tumor destruction in these nodes was incomplete. In the rabbits with a shorter transplantation-to-treatment interval the initial lymphadenograms showed that the nodes were smaller after injection of radioactive than inactive Lipiodol. These findings were confirmed on macroscopic examination of the regional pelvic lymph nodes. In the rabbits with short transplantation-to-treatment intervals, radiation changes in tumor cells due to the ^{131}I-Lipiodol could be followed to complete destruction. There was a clear increase in the survival time of the treated animals after a short transplantation-to-treatment interval. In rabbits with the longer transplantation interval there was little difference in survival rate between control and treated animals. In dosimetry studies very large doses of radiation were measured in excised rabbit nodes, up to 75,000 rad from an administered dose of 5 mCi ^{131}I in 1 ml Lipiodol. Due to the relatively short penetration of the β particle of the isotope, this radiation is selectively given to the lymphatic system. No toxic effects due to the radioactive isotope combination was observed in the rabbit. It is concluded that ^{131}I-Lipiodol can destroy microscopic-sized metastases in lymph nodes. In 50 patients with malignant melanoma the dose of ^{131}I given was 40 to 45 mCi in 4 ml Lipiodol for the lower limb and 30 to 35 mCi in 2 ml for the upper limb. The levels of radioactivity in blood and urine were routinely measured. Average blood levels of ^{131}I comprised 0.01% of the administered dose per liter whereas average urine excretion levels amounted to 1% of administered dose in each 24 hr. The complication rate of endolymphatic therapy was low. In one patient a radionecrotic ulcer developed that needed excision and grafting. Occasionally there was a transitory pyrexia of 1 to 2°C in the early phase. Long-term studies failed to show any lung damage arising from overflow of radioactive contrast material to the lungs. (BBB)

38731 PERMANENT HEALING OF A BONE SARCOMA AFTER X IRRADIATION. Fuchs, G. (Kaiser-Franz-Joseph-Spital, Vienna). Krebsarzt, 24: 16-20(1969). (In German).

The permanent healing was reported of a Ewing bone tumor located in the lower ⅓ of the fibula of a 42-yr-old patient following treatment with fractionated x irradiation in two fields, that received total doses of 2600 R each. Each dose fraction amounted to 200 R of 150 KV x irradiation. Immediately prior to each single irradiation treatment the tumor area was subjected to shortwave diathermy for 20 min until the patient experienced a sensation of warmth in the area treated. This procedure induced hyperemia in the area, and may have sensitized the tissues to the irradiation dose administered just after the diathermy treatment. New bone formation was observed within

two months after initiation of the irradiation treatments. No recurrence of the tumor was observed over a period of 13 yr when the patient died. No irradiation injuries were observed, but the skin became slightly thickened at the irradiation site. The combination of diathermy and irradiation treatment proved effective also for treatment of other primary or metastatic bone tumors, as well as for inoperable mammary carcinomas and intrathoracic tumors. (BBB)

38732 INTRA-ARTERIAL IRRADIATION. Simon, Norman (Mt. Sinai School of Medicine, New York). Bull. N. Y. Acad. Med., 45: 358-72(Apr. 1969).

Effects of intra-arterial injection of various radionuclides, especially ^{90}Y and ^{32}P incorporated into microspheres, on various organs, and the dosimetry employed with such β emitters, are considered. The location of microspheres within the body can be determined by a scan of the bremsstrahlung that results from the interactions of the β particles with tissue. Counting rates in bremsstrahlung scans may also be helpful in determination of the dose of radiation. In therapy, calculated doses as high as 50,000 rad have been used, but the usual dose to the liver is 10,000 to 20,000 rad. The dose of radiation to the liver in the studies described was 1500 to 6000 rad. This can be given to the right lobe with 7 to 30 mCi of ^{90}Y in 3 to 6 ml of dextran. Even with a dose of 6000 rad, patients tolerated the treatment well; no nausea or significant leukopenia ensued. Experience in treating 23 patients with brain tumors, 14 with glioblastoma multiforme and 9 with metastatic cancer, also showed the relative safety of the procedure. The patients tolerated it well. Its use in lung and kidney tumors is also described. (BBB)

38733 COMPARISON OF SURVIVAL TIMES OF PATIENTS WITH BRONCHIAL CARCINOMA TREATED EITHER BY DAILY FRACTIONATED DOSES OR BY THE SPLIT TECHNIQUE. Lessel, Almuth (Institut fuer Krebsforschung, Berlin). Strahlentherapie, 137: 518-21(May 1969). (In German).

It was investigated if radiation therapy with daily fractions in a continuous series has a different efficiency when compared to the so-called split-method, in the treatment of bronchial carcinoma. Two groups of similar prognostic outlook were compared: 118 patients, 6 weeks irradiation time, 6200 R tumor dose and 183 patients, 8 weeks irradiation time with a 3 weeks pause and 8000 R tumor dose. The survival rate does not show any advantage of the split technique (after 1 year 39% vs. 36%, after 2 years 15% vs. 12% and after 3 years 8% vs. 5%). A basic advantage can, however, not be excluded, because most of the patients die from distant metastases. (auth)

38734 LARGE DOSE FRACTIONS IN TELECOBALT RADIOTHERAPY. A REPORT ON THE TREATMENT OF INOPERABLE LUNG CANCER. Taskinen, Pentti J. (Southern Saimaa Central Hospital, Lappeenranta, Finland). Strahlentherapie, 137: 522-9 (May 1969).

The theoretical and practical background of the large dose fraction technique is described. A few large fractions are more effective than daily fractions in oxic conditions, and during the interval between fractions normal tissue recovers better than tumor tissue. Results of the treatment of inoperable lung cancer with doses 8 × 400 rd and later 8 × 430 rd twice weekly or 3–4 × 700 rd once weekly are presented. The half-year survival rate for the whole material was 59%, 75%, for squamous cell carcinomas and 48% for other carcinomas, and the 1-year survival rates 48, 60, and 9%, respectively. The median survival for squamous cell carcinomas was 13.5 months, for small cell carcinomas 4.5 months, and for others 6.0 months. Further clinical comparative studies are needed to find out the most effective fractionation scheme. (auth)

38735 EXTERNAL IRRADIATION COMBINED WITH HYPERBARIC OXYGEN IN THE TREATMENT OF ADVANCED CERVICAL CARCINOMA. Pizey, N. C. D. (Bristol and Royal United Hospital, Bath, Eng.); Bullimore, Jill A. J. Obstet. Gynaecol. Brit. Commonwealth, 75: 1275-8(Dec. 1968).

Oxygen-sensitized tumor cell destruction was examined in a clinical study of 33 patients with cervical carcinoma treated at 3 atm O_2 with ^{60}Co γ radiation or a 15-MeV linear accelerator. In 17 cases a tissue maximum dose of 3500 R was given in six increments over 18 days. The area treated included the uterine body and cervix, upper third or half of the vagina, the parametria and the pelvic nodes. The crude 5-yr survival in this group was 56%. Complications included three cases of fractured neck of femur which required pinning. In no case was there evidence of avascular necrosis of metastatic involvement of the bone. Two patients developed severe pelvic fibrosis and two suffered intermittent small bowel obstruction, but neither required surgical relief. In 16 other cases treated, the volume of tissue treated was slightly larger than in the previous series. When this method was introduced, a tissue maximum dose of 3500 R in six fractions in 18 days was administered. However, the dose and technique were modified, as there was a high incidence of bowel complications in the earlier cases. A maximum of 3500 R is now given in seven treatments in 21 days. The high morbidity encountered in the second series may be related to the slightly larger tissue volume treated. (BBB)

38736 RESULTS OF HEMANGIOMA TREATMENT WITH CONTACT IRRADIATION. Gross, Erika; Luger, A. (Univ.-Hautklinik, Vienna). Dermatol. Wochenschr., 153: 142-59 (Feb. 11, 1967). (In German).

Incidence of ulceration in 1314 hemangiomas treated with x irradiation doses of from 250 to 8000 R was reported and discussed. Ulceration appeared in 6.2% of the cases, with highest incidence in patients treated with from 250 to 1000 R. The percentage of hemangiomas that became ulcerated was not related to the clinical form nor the area of the hemangioma. Almost all of the ulcerations appeared in patients 6 to 9 months old. Many of the hemangiomas that became ulcerated were located in the lower abdomen, sacral, or gluteal regions, where the frequency of ulceration was two to six times as great as in other body areas or in the extremities. The incidence and severity of ulceration after irradiation appeared to be partly related to mechanical irritation. (BBB)

38737 A PORTABLE ^{90}Sr SOURCE FOR THE IRRADIATION OF EXTRACORPOREALLY CIRCULATING BLOOD. Pichlmaier, H.; Frey, K. W.; Trepel, F. (Univ., Munich). Klin. Wochensch., 45: 550-1(May 15, 1967). (In German).

The construction and use of a portable 90-mCi ^{90}Sr source suitable for direct irradiation of circulating blood was described. The source was implanted into the lumen of an arteriovenous shunt directly in the path of the blood stream. The ^{90}Sr source was placed around the 5-mm silicone tube of the shunt and irradiated the lumen. The radioactivity was absorbed externally by a Plexiglas–Pb shield. The surface dose of the source amounted to ~25 mR/hr, and at 40 cm distance the dose was ~0.7 mR/hr. Anticoagulants were given. Irradiation of blood by this method in animals resulted in a $\frac{1}{3}$ reduction of peripheral lymphocytes within 18 days. The granulocyte and monocyte counts were not affected by the irradiation. Application of the irradiation procedure to renal transplantation was proposed. (BBB)

38738 COMPARED TO ^{60}Co BETATRON IMPROVES CANCER SURVIVAL. J. Amer. Med. Ass., 208: 1284(May 26, 1969).

A long-term study of patients with advanced cervical cancer treated with high-energy radiation showed that nearly twice as many survived for 5 yr after betatron treatment. More than 300 patients were treated by either betatron or ^{60}Co for a 6-yr period ending in 1964. Of these, 126 cases were followed for 5 years. The external betatron radiation of 5200 to 5500 rads, administered in daily doses over 4 wk, was supplemented by a single intrauterine radium dose of 3,000 rads. Thirty-nine of 65 betatron-treated patients (60%) survived 5 yr; 21 of 61 patients treated with ^{60}Co (34.4%) survived. Survival rates also were significantly better among betatron patients with tumors that were far advanced. Reasons for differences in survival rate are presented. (C.O.)

38739 EVALUATION OF RADIOTHERAPY OF TUMORS IN THE PINEAL REGION BY VENTRICULOGRAPHIC STUDIES WITH IODIZED OIL. Suzuki, Jiro; Hori, Shigeaki (Tohoku Univ. School of Medicine, Sendai). J. Neurosurg., 30: 595-603(May 1969).

The effects of ^{60}Co γ irradiation of pineal tumors was studied in five cases by ventriculography, and death in two cases as a result of excessive radiation doses, are reported. Changes in the tumors treated with ventriculoatriostomy and radiotherapy were followed by iodinated oil (Myodil) ventriculography. After 1 to 14 days of continuous ventricular drainage, ventriculoatriostomy was performed in all cases. Radiotherapy was then given with an initial dose of 50 to 150 R, maintenance doses of 125 to 200 R, and total focal doses of 3475 to 6200 R within 5 to 9 weeks. In one case an additional dose of 4350 R after an interval of 13 months was given. In another case, after 2 weeks of irradiation, the patient complained of headache and vomiting, which disappeared with prednisolone treatment. From the 4th week, however, she again developed general malaise, anorexia in addition to fever. Six weeks later these symptoms became worse and white cell count decreased to 3000, so that irradiation was discontinued at 3475 R. At that time Myodil was not seen in the ventricles but was found in the spinal canal. The patient died 1 week later. This indicated that although irradiation is very effective, it can be fatal by damaging important centers in adjacent areas. When patients have endocrine disturbances, especially panhypopituitarism, they may be less resistant

to irradiation. Autopsy of another fatal case also revealed complete elimination of the tumor by irradiation but radiation overdose was suspected here too as the cause of death. Avoidance of overdose as well as administration of supplementary hormone therapy is important in treatment of this disease. (BBB)

38740 LEUKEMIA IN POLYCYTHEMIA VERA: RELATIONSHIP TO SPLENIC MYELOID METAPLASIA AND THERAPEUTIC RADIATION DOSE. Lawrence, John H.; Winchell, H. S.; Donald, W. G. (Univ. of California, Berkeley). Ann. Intern. Med., 70: 763-71(Apr. 1969).

Sequalae of irradiation were assessed in 181 cases followed after treatment with ^{32}P or external irradiation for polycythemia vera. Only ^{32}P irradiation was received by 123 patients whereas the remaining cases were also x irradiated. Forty-five (25%) developed significant splenic myeloid metaplasia, and 26 of 181 (14%) developed an acute myelogenous leukemia-like state. Sixteen patients had both acute leukemia and significant splenic myelopoiesis or myeloid metaplasia (that is, 16 of 45 or 36% of all cases with myeloid metaplasia developed acute leukemia), and 10 patients had only acute leukemia but no significant splenic myeloid metaplasia (that is, 10 out of 136 or 7% of all patients without myeloid metaplasia developed acute leukemia). Patients who failed to develop myeloid metaplasia or acute leukemia, or both, were older at the time of onset and diagnosis than those with these developments and did not survive as long. The survival of patients who developed acute leukemia was not significantly different from patients who died with significant myeloid metaplasia alone. The largest values of overall radiation exposure (both ^{32}P and x rays) times time at risk were received by patients dying with splenic myeloid metaplasia alone. The overall incidence of acute leukemia in this series of patients with polycythemia vera is 20 to 40 times greater than that expected for a population of normal human subjects exposed to similar radiation doses and times at risk. It was concluded that development of significant splenic myeloid metaplasia and acute leukemia-like states are part of the evolutionary history of polycythemia vera. Myeloid metaplasia usually precedes the appearance of acute leukemia. Incidence of acute leukemia in patients treated with ^{32}P may be primarily a result of prolonged survival rather than irradiation. (BBB)

38741 RADIATION INDUCED PNEUMONITIS AS A COMPLICATION AFTER RADIOTHERAPY OF BREAST CARCINOMA. Gimes, B. (Staedt. Krankenhauses Peterjy Sandor-utca, Budapest). Fortschr. Geb. Roentgenstr. Nuklearmed., 108: 638-43 (May 1968). (In German).

Between 1963 and 1965, sixty-two patients with carcinoma of the breast were irradiated before or after operation, most treatments being given postoperatively. In eight patients radiation pneumonitis developed: in all, changes were first observed towards the end of treatment, together with an erythema. The radiographic appearances of the first, reversible, state are described. Attention is drawn to the increasing incidence and possible treatment. (F.S.)

38742 MICROSCOPIC, HISTOLOGIC, AND HISTOCHEMICAL STUDIES ON THE RADIATION-DAMAGED INTESTINE FOLLOWING BIAXIAL TELECOBALT THERAPY IN CERVIX CANCER. Hoppe, Elfriede (Humboldt Univ., Berlin). Cesk. Radiol., 22: 47-56(Jan. 1968). (In German).

A series of patients suffering from advanced stages of carcinoma of the cervix were treated with cobalt-60 teletherapy exclusively. Total doses ranged between 6000 and 9000 R. Approximately ten months after treatment, six of the patients developed serious gastrointestinal complications requiring partial resection of jejunum, ilium, and colon. Histological examinations of the resected tissues showed changes identical with those seen after deep x-ray or radium irradiation. Most characteristic were thickening of vascular walls and submucosal edema containing large amounts of neutral mucopolysaccharides. Progression of the edema to fibrosis was not seen; therefore, it must be a later process. (H.B.G.)

38743 PTERYGIUM: SURGICAL EXCISION FOLLOWED BY BETA IRRADIATION. Rowen, Gerald E. Rocky Mt. Med. J., 65: 47-9(May 1968).

Previous results and complications with the use of radiation to treat pterygium are reviewed and cases of ^{90}Sr β irradiation for this condition reported. All previous irradiation technics are less susceptible to good control than ^{90}Sr β irradiation, which was first used in 1949 to 1950. Consequently, numerous serious complications were reported following huge doses of irradiation given for vernal catarrh, corneal vascularization, tumors, and other diseases, and these complications reported repeatedly throughout the literature gave an illusion that the incidence of complications was far greater than it actually was. The development of cataract is a theoretical irradiation hazard but practically is of minimal importance. Of 695 cases previously reported, only five had cataracts of the sector type and none of these went on to visual loss. In a recent report, 83 eyes were treated with 1000 to 7200 rep given during the first three postoperative days. Seven eyes showed sector-type nonprogressive opacities, and these occurred in the patients receiving higher doses. No patient receiving 3000 rep or less developed any opacities during the 5- to 8-yr follow-up period. There seems to be some latitude allowable in the amount and timing of the β irradiation. For instance, 3000 rep in divided doses of 1000 rep weekly was found satisfactory, while a single dose of 1500 to 2500 rep has been advocated by others. Irradiation should be employed only by someone fully aware of its physical, pathologic, and therapeutic potentialities. In the method that is described, the pterygium is excised by lamellar dissection including the head and the body. Within 24 hr the limbal area is given 1380 R with the ^{90}Sr applicator and the patient is given steroid treatment. Irradiation is repeated in 2 weeks. An extra dose of irradiation may be given if the pterygium is especially vascular. No recurrences occurred with two doses 2 weeks apart, but when a single dose was given, recurrences did occur. Steroids were used postoperatively because of their anti-inflammatory effect and their contribution to the comfort of the patient. A review of the literature revealed only one case with a serious complication following the recommended treatment by surgery followed by β irradiation. The serious sequelae of irradiation can be traced mainly to excessive dose. However, it is apparent irradiation may be used with safety when certain precautions are taken. For best results and greatest safety, irradiation should be given in divided doses and the total dose should not exceed 3000 rep. (BBB)

Blast and Thermal Effects

38744 BREAST CANCER AFTER EXPOSURE TO THE ATOMIC BOMBINGS OF HIROSHIMA AND NAGASAKI. Wanebo, C. K.; Johnson, K. G.; Sato, K.; Thorslund, T. W. (Atomic Bomb Casualty Commission, Hiroshima). New Engl. J. Med., 279: 667-71(Sept. 26, 1968).

Evidence for breast cancer being caused by exposure to atom bombing was sought in the Adult Health Study (AHS) sample which included 12,003 female survivors and others carefully chosen from among residents of Hiroshima and Nagasaki in 1950. The search revealed 31 women in the AHS in whom cancer of the breast had developed after 1945. The 31 cases are listed according to exposure status (ground distance from the hypocenters and total rad dose). The onset in 9 of the 31 was during the period 1946 to 1957, and in 22 between 1958 and 1966. In women exposed to 90 rad or more, breast cancer developed at a rate 2 to 4 times the rates observed in the comparison group of the study sample and in the reported rates for Miyagi Prefecture. The onset of breast cancer relatively early in life, before the menopause, distinguished the irradiated from the control group. A carcinogenic effect of irradiation appears to have been established for breast cancer. (BBB)

38745 PATHOLOGY OF EARLY DEATH IN ATOMIC BONB CASUALTIES IN HIROSHIMA: MORPHOLOGICAL FEATURES AND PHYSICAL ANALYSIS OF CAUSATIVE FACTORS. Miyake, Masashi (Tokyo Univ.); Yokoyama, Takeshi; Yamaguchi, Kazuyoshi; Hara, Mitsuru; Sugano, Haruo; Kasuga, Tsutomu; Maruyama, Takashi; Inada, Tetsuo. Acta Pathol. Jap., 17: 517-33(Nov. 1967).

Material from 213 autopsy cases collected by the Pathology Team of the Special Committee for Investigation of Effects of Atomic Bombs, the National Science Council of Japan, was reviewed. The sequence of the events, especially in the bone marrow from cases dying between a few days and 120 days after exposure, was discussed in the light of newer knowledge in radiation pathology. The regeneration of hematopoiesis in the irradiated bone marrow appeared to be initiated from surviving differentiated marrow cells and not from the so-called stem cells. Distortion of bone-marrow structures may have some bearing on abnormal regeneration, hyperplasia, and neoplasia of the marrow elements. In view of the discrepancies in the estimation of the effects of internal radiation, some experiments in animals were performed to determine the effects of internal as compared to the external irradiation. The data obtained indicated that the role of internal sources is very small and negligible. Thus the induced activity in the body from ^{24}Na and ^{32}P activation from thermal and fast neutrons was determined. Calculation of the tissue absorbed dose showed that the dose from both β and γ rays gave 0.027 rad per rad of the neutron irradiation dose. (BBB)

38746 STUDY OF THE OPHTHALMOLOGIC STATUS IN CHILDREN EXPOSED TO ATOMIC BOMB IN UTERO IN NAGASAKI. Kawamoto, Sadahisa; Fujino, Tadashi; Fujisawa, Hideo

(Atomic Bomb Casualty Commission, Nagasaki). Nippon Shonika Gakkai Zasshi, 72: 392-7(Apr. 1, 1968).

An ophthalmologic study was conducted from August 1963 to March 1964 on 266 children who were in utero at the time of the atomic bombing. They were divided into three groups for comparison: Group I (81) whose mothers were within 2000 m of the hypocenter, Group II (103) whose mothers were between 3000 and 4999 m from the hypocenter, and Group III (82) whose mothers were not in the city at the time of the explosion. Stages of gestation for the children at the time of the bombing were variable. The ophthalmic examination included use of a hand-held ophthalmoscope and slit-lamp biomicroscope. Visual disability was more frequently noted in the children whose mothers were not in the city (Group III), but no difference was noted by sex or by distance for those within the city (Group I and II). In Group I, no correlation was found for distance and trimester of pregnancy. Segmental iris heterochromia was not seen, but heterochromic spots or nevi of the iris were found in 17% of the subjects. No difference was noted by sex and comparison group. Persistent pupillary membrane and persistent hyaloid artery were more frequently noted in Groups I and II. A statistically significant difference was found in the frequency of persistent pupillary membrane between the groups within the city (Group I and II) and Group III. However, in Group I the frequency did not differ by distance and trimester of pregnancy. Lenticular opacities, including small vacuoles, were more frequently found in Group I and II, but no statistically significant difference was observed between the Group I and Group III. (BBB)

Radiation Effects on Animals

Refer also to abstracts 38478, 38480, 38484, 38486, 38510, 38511, 38540, 38541, 38616, and 38894.

38747 (UCSF-10-P-2-75) ENDOGENOUS NON-PROTEIN SULFHYDRYL AND CELLULAR RADIOSENSITIVITY. Harris, J. W. (California Univ., San Francisco. Lab. of Radiobiology). May 1969. Contract AT(11-1)-Gen-10. 14p. (CONF-690525-1). Dep. CFSTI.

From 2nd International Symposium on Radiosensitizing and Radioprotective Drugs, Rome, Italy.

Ehrlich ascites tumor cells in vivo and HeLa cells in vitro increased their intracellular non-protein SH (NPSH) concentration as they moved into and through S phase of cell cycle. Although increasing NPSH coincided with a period of increasing radioresistance, other evidence suggested that the relation may not be a causal one. Chinese hamster cells in plateau growth contained only one-third the NPSH concentration of exponentially growing cells, yet the two were equally sensitive (same D_q) to a single dose of X rays. Ehrlich ascites tumor cells treated with methyl phenyldiazenecarboxylate (a specific NPSH oxidant under the conditions employed) were not significantly more radiosensitive than untreated cells, although they contained only 20 to 30% of their normal NPSH complement when irradiated. It was concluded that although endogenous NPSH did fluctuate as cells move around the cell cycle, these fluctuations were probably not the cause of age-dependent radiosensitivity. (auth)

38748 SOME ASPECTS OF COMPUTERS IN RADIOBIOLOGY. Emery, E. William (Royal Postgraduate Medical School, London). Brit. Med. Bull., 24: 244-8(1968).

Some model radiobiologic systems that are amenable to computer analysis are presented. One example is the study of the relation between the fraction of cells surviving a given radiation dose and the magnitude of the dose. Such studies are most easily carried out with single-cell suspensions, of bacteria for instance, but there are a few techniques for making similar studies in mammals. The results are presented in the form of a cell-survival curve in which the logarithm of the surviving fraction is plotted against dose. With human kidney cells in tissue culture the curve is given by a model in which inactivation arises not by single hits on several targets, but by the accumulation of a minimum number of hits by a single target. By use of a program in Elliott 803 Autocode, the effect of combining models with varying distributions of hit numbers was explored, a situation which could be interpreted either in terms of variation among the biological targets or among the size of the individual interactions of the radiation with matter, an interaction with large energy transfer being equivalent to a number of individual hits. It was shown that results could be matched by suitable combinations of hit numbers. Also described is a means to deal with quantal data that can be reduced to linear form by a probit transformation. The original application was to the survival of irradiated mice, but the program has also been applied to the dose required to control tumor growth, and has wide potential applications in radiobiology. Subject to limitations of computer size, it will deal with any number of groups: The output compares the actual numbers of survivors with those predicted by the fitted lines; an analysis of variance is given from which it can be seen, for instance, whether a fit by a set of parallel probit lines is justified. Mean lethal dose (LD_{50}) for each group is printed out with confidence limits, and also the differences in LD_{50} between the controls and the various other groups. (BBB)

38749 PHASE-CONTRAST OBSERVATION ON INFLUENCE OF RUBY LASER-RADIATION ON LIVING CELLS. Grosman, Z.; Puza, V.; Stransky, P. (Charles Univ., Hradec Kralove, Czech.). Folia Biol. (Prague), 15: 205-8(1969).

Changes induced by irradiation by the focused beam of laser, were observed in living cells of the HeLa line cultured in Rose's chambers. The changes were registered by microphotography. Ruby laser VUVET 2000 L was used as a source of the radiation of $\lambda = 6{,}943$ Å. The output energy was maximally 0.5 J and was regulated by absorbing filters placed between the ruby and the ocular. The diameter of the bulk of the beams was 5 mm., the divergences were less than 100'. The effect of the radiation on living cells and their constituents depended on the content of Janus green in culture medium that strongly absorbs the radiation of the used wavelength. The differences in the effect depended upon the localization of the spot: to evoke the same effect, higher energy was necessary for the irradiation of the nucleus and nucleolus than for the cytoplasm. The thermal effect seems to be the most probable cause among many other mechanisms of damage according to phase-contrast microscope observations on living cells. (auth)

38750 SYSTEM ASPECTS OF GRANULOPOIESIS AND RADIATION EFFECTS. Patt, Harvey M.; Maloney, Mary A. (Univ. of California Medical Center, San Francisco). Curr. Top. Radiat. Res., 5: 115-40(1969).

The pattern of organization of the granulocyte population of bone marrow (progenitor elements, or stem cells, and proliferating, maturing, and functional cells in an ordered sequence) is described in relation to repopulation in the femur diaphysis in rabbits after complete removal by dextran perfusion. Following this, the parameters, dimensions, and cell fluxes of the granulocyte steady state are discussed; the manner in which the granulocyte steady state is regulated is then considered. Results of investigations on the radiosensitivity of constituent granulocytes (resting, proliferating, maturing, and functional cells) are discussed; it was stated that granulocyte and erythrocyte production may have similar radiosensitivity in the rodent since virtually all information on this subject was derived from research on rodents. The sequence and kinetics of depopulation and repopulation after irradiation as functions of the pattern of cell renewal in an organized tissue are considered; system aspects of radioinduced granulocytopenia (latent period, initial granulocytopenia, and minimal level and recovery kinetics) are used. Granulocytes and their role in radiation lethality close out the discussion. (C.O.)

38751 STUDIES ON THE SENSITIVITY OF MAMMALIAN CELLS TO ULTRAVIOLET IRRADIATION IN VITRO. Buder, E.; Schramm, T.; Wetzel, R.; Graffi, A. (Institut fuer Biophysik, Berlin. Institut fuer Krebsforschung, Experimenteller Buereich, Berlin). Arch. Geschwulstforsch., 33: 319-30(1969). (In German).

Different types of mammalian cells were irradiated with uv light of 254 nm wavelength, and uv doses producing first morphologic-cytological effects were determined. Such experiments are important for testing possibilities of uv radioinduced malignant transformation of normal cells and for carrying out uv optical investigations, for instance, microspectrophotometric studies. The results showed that different cell types respond differently to uv irradiation and that first morphologically visible effects of uv ($\lambda = 254$ nm) on cell cultures are associated with a certain minimum dose. Indications of an uv-radioinduced malignant transformation in such experiments could not be obtained. (auth)

38752 THE EFFECT OF A GROWTH-ENHANCING SUBSTANCE, FROM LEUKEMIC CELLS AND NORMAL MOUSE EMBRYO FIBROBLASTS, ON LEUKEMIC CELLS IN TISSUE CULTURE. Pluznik, Dov H. (Albert Einstein Coll. of Medicine, Bronx, N. Y.). Israel J. Med. Sci., 5: 306-12(May-June 1969).

X-irradiated myelocytic leukemic cells and mouse embryo fibroblasts release a substance that enhances the growth of leukemic cells. This substance is different from another substance that is also released from mouse embryo fibroblasts and that induces growth and maturation of normal granulocytes and macrophages. The growth-enhancing factor for the leukemic cells can diffuse through agar and can be obtained in an active form in a conditioned medium. It is dialyzable, which suggests that it is different from

other known substances that enhance and induce growth of other types of cells in tissue culture. (auth)

38753 KINETICS OF EHRLICH ASCITES TUMOR CELLS IN MICE FOLLOWING SINGLE OR FRACTIONATED WHOLE-BODY RADIATION. PART I. COMPARATIVE INVESTIGATIONS WITH 200 kv X RAYS, ^{60}Co GAMMA, AND ^{137}Cs GAMMA. Chone, Bruno; Blind, Edmund; Thauer, Detlef (Univ., Heidelberg). Strahlentherapie, 137: 467-77(Apr. 1969). (In German).

Mice were injected intraperitoneally with Ehrlich ascites tumor cells and each series of animals was exposed to various doses of either x rays, cobalt-60 gamma rays or cesium-137 gamma rays. At various times after exposure, tritium-labeled thymidine was injected intraperitoneally and, one hour later, samples of ascites cells were analyzed histologically, cytochemically, and autoradiographically. Results are discussed as to the mitotic cycle and to radiation dose. (H.B.G.)

38754 RADIOSENSITIZATION OF EHRLICH ASCITES TUMOUR CELLS BY A SPECIFIC ANTIBODY. Ghose, T.; Cerini, M. (Monash Univ., Melbourne). Nature (London), 222: 993-4(June 7, 1969).

It is stated that an antibody against the mouse Ehrlich ascites carcinoma (EAC) can be conjugated with enough ^{131}I to prevent the in vivo growth of EAC cells exposed in vitro to the radioiodinated antibody. In order to avoid the introduction of more than the maximum tumor-suppressive dose of the radioiodinated antibody into EAC-bearing mice it is necessary to determine the minimum EAC-suppressive dose of ionizing radiation acting alone or in conjunction with the anti-EAC antibody. The studies described showed that exposure of EAC cells to the anti-EAC antibody rendered them more susceptible to the tumor-suppressive effect of x irradiation. (UK)

Invertebrates

Refer also to abstracts 38518, 38530, 38537, 38550, and 38912.

38755 EFFECTS OF RADIATION, ANTIBIOTICS, AND ALKYLATING AGENTS ON CELL DIVISION AND GROWTH IN THE CILIATE SPATHIDIUM SPATHULA. Williams, Donald B. (Oak Ridge National Lab., Tenn.). J. Protozool., 15: 811-16 (Nov. 1968).

S. spathula is very sensitive to division inhibition after x irradiation. Five kR delivered to animals 1 hr into the cell cycle prolonged the period until the next division to about two times the normal length. The next two cell cycles, however, were shorter than normal, and by the fourth division irradiated cells recovered the normal division rate. During this division delay, scanning interference microscopy showed that growth in dry mass continues; at the first postirradiation division the cells average three times the normal dry mass. After the second postirradiation division, dry mass is 1.5 times the normal amount. Dry mass measurements were not made beyond the second division. Giant cells produced by irradiation had enlarged macronuclei, indicating that DNA synthesis is not inhibited by a dose of x rays that block division. Mitomycin C and triethylene melamine, agents that attack or damage DNA, also blocked division and caused giantism in Spathidium. This suggests that damage to DNA in the macronucleus, micronucleus, or other organelles may be much more effective in delaying cell division than cell growth. (BBB)

38756 IN VITRO DEVELOPMENT OF INVASIVE LARVAE OF NEMATODES TO PARASITIC STAGES. Eckert, J. (Institut fuer Parasitologie, Hanover). Z. Parasitenk, 29: 242-74(1967). (In German).

Experiments on the in vitro development of some nematode species gave the following results: In modified "Ae" medium (Leland, 1963) (medium H) the trichostrongyle species Cooperia punctata and Ostertagia leptospicularis developed from exsheated 3rd stage larva to the mature stage, Ostertagia ostertagi to the 5th, and Nematodirus sp. to the 4th stage. Oesophagostomum sp. from pig was cultivated to the 5th stage. The influence of different factors on the parasitic development of Cooperia punctata was studied in vitro: In comparative experiments with different media medium H (initial pH 7.0–7.3; gas phase air) gave the best results. The medium contained chick embryo homogenate extract, serum, caseine hydrolysate, liver extract, vitamins, antibodies, and Earle's solution. In 16 of 20 experiments with this medium a development to the 5th stage was achieved, in 7 of these experiments mature stages also occurred. The time required for their development was about twice as long as in the natural host. The eggs laid by females in cultures did not develop. For the development of Cooperia punctata the optimal pH range was 6.0 to 7.6. In cultures incubated with carbon dioxide-air mixtures more 3rd stage larvae exsheated and more 4th stage larvae developed than under air. Under a gas phase of oxygen no development to the 4th stage took place in most cultures, but the larvae survived. Under nitrogen 3rd stage larvae soon died. In low oxygen tensions (2; 5; or 10%) a development up to the 4th stage was observed. From x-irradiated larvae (100; 80; 40 kR) fewer 5th stages developed than from normal larvae; the percentage of females increased with increasing irradiation. (auth)

38757 VACCINATION AGAINST PLASMODIA. Zuckerman, Avivah (Hebrew Univ., Jerusalem). Israel J. Med. Sci., 5: 429-34(May-June 1969).

Recent studies on the vaccination of monkeys, mice, and rats with nonviable or attenuated preparations of homologous Plasmodium berghei and P. knowlesi are reviewed. Erythrocytic stages of the antigen were used in all cases except one (P. berghei in mice) in which sporazoites were used. In the cases of P. berghei, the antigen was inactivated by high doses of x radiation (10,000 to 40,000 R in the case of erythrocytic stages and 2,000 to 15,000 R in the case of sporozoites). The degree of protection against challenge afforded by the x-irradiated antigen was marked and in some cases complete. In all cases, the larger the irradiation dose or in the case of sporozoites, the larger the vaccinating dose, the more effective the immunization. From the immunogenic work on rodent and simian plasmodice, it seems possible that the immumogenic factor may reside not in a soluble component of the plasmodium, but rather in a relatively insoluble one. If this is the case, immunoelectrophoresis or disc electrophoresis studies might not include the immunogenic factor. (E.R.B.)

38758 EFFECT OF ^{60}Co INTERNAL IRRADIATION ON THE LIVER OF THE INDIAN CATFISH, HETEROPNEUSTES FOSSILIS BLOCH. Srivastava, Pratap N.; Ram, Sewbarath (Univ. of Rajasthan, Jaipur, India). Strahlentherapie, 137: 499-507(Apr. 1969).

Indian catfish, Heteropneustes fossilis Bloch, were intraperitoneally injected with ^{60}Co, 5 μCi, 10 μCi, 20 μCi, and 30 μCi per fish. The controls were injected with $CoCl_2$ equivalent to the maximum dose-level of 30 μCi. Internal radiation resulted in condensation of hepatocytoplasm, enlargement of nuclei with hypertrophic nucleoli, congestion and dilatation of blood vessels, hydropic degeneration and hemorrhage. Peripheral areas of the liver were occasionally enveloped by collagenous layers. The pattern of damage is similar in 5 μCi and 10 μCi injected fish, maximum destruction taking place by 4 to 5 days, reparative activities starting by the fifteenth day, and almost a normal hepatic picture is observed by the fiftieth day. Twenty and 30 μCi of ^{60}Co initiate hepatic degradation as early as 4 hours and this continues to intensify until the end of the observational period. The liver in fish is as radiosensitive as the intestine. (auth)

38759 RADIATION SENSITIVITY OF TWELVE SPECIES OF ARTHROPODS. Menhinick, Edward F.; Crossley, D. A. Jr. (Oak Ridge National Lab., Tenn.). Ann. Entomol. Soc. Amer., 62: 711-17(July 1969).

Eleven species of insects and 1 species of isopod were exposed to γ radiation from ^{60}Co with total doses ranging from 1 to 512 kR in 100% increments. Insects were irradiated and maintained under comparable conditions at 28°C. Mean and median life expectancy were estimated for each dose level. Life expectancy was significantly lowered for all species by exposure to 8 kR or more. Most species were affected by 4 kR. Exposure to 1 or 2 kR generally had no effects. Of the species tested, the American cockroach, Periplaneta americana (L.), was the most sensitive to radiation; the black carpet beetle, Attagenus piceus (Olivier) was the least sensitive. Correlations between radiation sensitivity and taxonomic grouping were poor. However, within insect orders size appeared to be a good basis for estimating mortality response to irradiation. Large species were found to be more sensitive to irradiation than smaller species. (auth)

38760 FEEDING BEHAVIOR OF LARVAE OF THE WESTERN CORN ROOTWORM: NORMAL LARVAE AND LARVAE MAXILLECTOMIZED WITH LASER RADIATION. Branson, Terry F.; Ortman, Eldon E. (Dept. of Agriculture, Brookings, S. Dak.). Ann. Entomol. Soc. Amer., 808-12(July 1969).

Larvae of Diabrotica virgifera LeConte (Coleoptera: Chrysomelidae) cannot live on the roots of oats, but results showed that rootworm larvae were more attracted to oat roots than they were to corn roots and feeding was initiated on oat roots. No maxillectomized larvae, maxillectomized and labiumectomized larvae, or normal larvae ingested an appreciable amount of oats. The maxillary palpi were important in the detection of sucrose (a feeding stimulant), and appeared to inhibit feeding when sucrose was absent. However, the maxillae were not the only receptors that detected sucrose absence. Other receptors also appeared to

detect a feeding deterrent in oat roots. Rootworm larvae seemed constantly to test their substrate with their maxillary palpi, and the palpi continually inhibited the biting response unless they contacted positive stimuli. If the substrate contained a feeding stimulant such as sucrose, the stimulant was detected partly by the maxillary palpi, and the larvae continued to feed. But if a substrate such as oat roots also contained a strong deterrent substance, this negative stimulus was detected by receptors other than the maxillary palpi and feeding ceased. Laser radiation was used to maxillectomize rootworm larvae. This technique may be useful in maxillectomizing other small insects and in studying the function of other sense organs. (auth)

38761 THE EFFECT OF RADIOACTIVE IRRADIATION ON THE VIABILITY OF WORM EGGS. Sauer, J. Z. Parasitenk., 31: 15(1968). (In German).

Lethal effects of ionizing radiation on eggs of intestinal parasites in sewage were studied. Eggs of the swine eelworm, Ascaris suum, were exposed to high doses of irradiation during various stages of their development. The studies showed that after Ascaris eggs obtained from the uterus were cultured in water for 1 or 2 days at 30°C with constant aeration they were very resistant to irradiation doses of up to 700 KR. In eggs incubated for 5 days 500 KR was sufficient to kill 98% of the development embryos in the egg cases. The embryos became increasingly susceptible to irradiation as the incubation time was increased. The irradiation doses required for a 98% lethality after 8, 12, 15, 18, and 22 days incubation times were 300, 200, 100, 50, and 10 KR, respectively. (BBB)

38762 THE EFFECTS OF OXYGEN AND NITROGEN POST-TREATMENTS ON THE SURVIVAL OF IRRADIATED STAGE-14 OOCYTES AND A POSSIBLE BASIS FOR SENSITIVITY DIFFERENCES BETWEEN STAGE-7 AND STAGE-14 OOCYTES OF DROSOPHILA MELANOGASTER. Sankaranarayanan, K. (Univ. of Leiden, Inst. for Radiopathology and Radiation Protection, Leiden). Mutat. Res., 7: 269-83(May-June 1969).

Mature (stage-14) oocytes of Drosophila melanogaster were exposed to different levels of x irradiation in nitrogen, oxygen, or air. Exposures in the first two cases were followed by post-treatments with either nitrogen or oxygen, while those in air were followed by nitrogen or air post-treatments. Egg-survival was used as a criterion to study the effects of such treatment combinations. It was found that: the dose-effect relationship observed was consistent with a one-hit survival kinetics; with post-irradiation anoxia, there was a significant reduction in survival; and this effect of anoxia could be reproduced even if the flies were post-treated with oxygen for the first 45 min following irradiation, and then with nitrogen for the next 45 min. The available data also support the conclusion that the stage-14 oocytes have more oxygen available than stage-7 cells under normal conditions in air. It is suggested that this differential oxygenation in air between the two germ-cell stages may constitute one of the several factors which contributes to the higher radiosensitivity of the stage-14 cells relative to the stage-7 cells. The Oxygen-Enhancement-Ratio for the stage-14 oocytes has been estimated to be between 3.52 and 3.85, which is much higher than 2.53–2.65 for the stage-7 oocytes. (auth)

38763 EFFECTS OF X RADIATION ON THE EMBRYONIC DEVELOPMENT OF MALE GONADS IN DROSOPHILA MELANOGASTER. Schweizer, Pascal (Univ., Zurich). Strahlentherapie, 137: 749-59(June 1969). (In German).

The development of male genital primordia of Drosophila melanogaster is studied after irradiation (3000 tot 4000 R) at various development stages. The last four segments of the larval stage at 48 and 72 hours were irradiated as well as the 0, 10 and 30 hours old nymph. A remarkable relation was observed between the extent of lesions and the age of the irradiated stage. This is discussed in view of the well-known reparation possibility of the genital primordia after UV irradiation or even after mechanical section. This restoration capability of the blastemes at the different stages has a particular significance on the extent of the lesion. (auth)

Vertebrates

Refer also to abstracts 38392, 38416, 38425, 38429, 38440, 38459, 38460, 38462, 38470, 38474, 38475, 38487–38489, 38496–38500, 38502–38509, 38514, 38518, 38522, 38529, 38532, 38601, 38614, 38618, 38619, 38625–38628, 38632, 38730, 38748, 38856, and 38860.

38764 (AD-677185) EFFECTS OF THE RATE OF DELIVERY OF IONIZING RADIATION ON THE LD50/30 OF RODENTS. Final Report, November 15, 1966–November 15, 1967. Gambino, Jerome I.; Faulkenberry, B. H. (Northrop Corporate Labs., Hawthorne, Calif. Life Sciences Lab.). May 1968. Contract F41609-67-C-0004. 47p. (SAM-TR-68-47). CFSTI.

Mortality and shock-avoidance performance were observed in Wistar albino rats subjected to pulsed ionizing radiation from two different nuclear reactors. In one, the n/γ dose ratio obtained ranged from 2.5/1 to 6.6/1, and the pulse width was 48 microsec. at half-amplitude. In the other, the pulse half-width was either 10 to 150 msec., and the n/γ tissue dose ratio used ranged from 1/23 to approximately 5.3/1. (auth) (TAB)

38765 (AD-686649) PROMPT REACTIONS OF THE RABBIT TO X RAYS. Hunt, Edward L. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 3, 1969. 34p. (USNRDL-TR-69-17). CFSTI.

Ionizing radiation is known to act as a stimulus for the visual and olfactory systems. Its capacity to act as a stimulus when regions of the body other than the head are exposed was investigated. The rabbit, maintained in a steady sleep-like state induced by reflex immobilization (animal hypnosis) was the test animal. The prompt occurrence of behavioral arousal, heart rate alteration, and/or a change in regular respiratory movements in response to a short, pulse of x rays (250 kVp) was used to indicate neural activation (stimulation). In contract with trunk exposure, exposure of the head, that included olfactory and visual structures in the field, produced reactions in from 74 to 84% of the tests. With an increase in dose rate to 3.6 R/sec (1¾ sec pulse), that produced a 100% response incidence with anterior-head exposure, exposure of the upper abdominal region (including the stomach) produced a 57% incidence. Response incidences of 43% and 33% were obtained with this exposure of the lower thoracic and lower abdominal regions, respectively, indicating that trunk sensitivity is not sharply localized. These results indicate that, although the anterior head regions is the most sensitive, exposure of abdominal or thoracic regions may also result in neural activation. (TAB)

38766 (AD-686733) SELECTION OF RADIATION-RESISTANT ANIMALS. Report for February 1966–October 1967. Peters, Ignatius G.; Hamilton, Horace E.; Melville, George S. Jr.; Ballinger, Edwin R. (School of Aerospace Medicine, Brooks AFB, Tex.). Jan. 1969. 17p. (SAM-TR-69-2). CFSTI.

Rodents were exposed at weekly intervals to an ethanol-saturated air ambient. Body weight was monitored before and after each exposure. Sedation and recovery times were observed. After a rest period of several days the animals were irradiated to a dose level at which a 100% mortality was expected. The postirradiation survival of the rodents was correlated ($P < 0.05-0.01$) in preliminary experiments with preirradiation ethanol-induced body weight changes. The weight change-survival relationship was observed in five different species of rodents. The correlation was found to be present for periods of time up to 21 days following stress testing. The test may be applicable to animals exposed to a dose range of several hundred roentgens at the dose level producing a high percentage of mortality. No detectable modification of the post-irradiation survival time of the stressed animals was observed. Plots of radioinduced mortality times were made for the five rodent species. (TAB)

38767 PROCESSES OF PHYSIOLOGICAL AND REPARATIVE REGENERATION IN MITOCHONDRIA. Manina, A. A. (Inst. of Experimental Medicine, Leningrad). Arkh. Anat., Gistol. Embriol., 52: 77-85(Mar. 1967). (In Russian).

Ultrastructure of mitochondria of the central nervous system is extremely dynamical under various functional conditions. It is characterized by high variability, plasticity of forms and volume manifested in alterations in relationships between the internal membranes, composition of the matrix, and their localization. However these dynamic changes are mainly of a regular nature, reflecting an interdependence of cytoplasmic and mitochondrial membranes. Alterating agents, different as to their character (total irradiation, oxygen insufficiency, overheating), brought about changes — although variously marked, but of a similar type, and of a non-specific character — in the brain mitochondria of the animals under study. Destructive processes developing in the mitochondria of the central nervous system due to the application of the alterating agents were, in their majority, reversible ones. Part of the mitochondria remained unaltered, maintaining their usual structure. Even a considerable impairment of mitochondria did not affect the continuity of their limiting membranes. The processes of reparative regeneration of the mitochondria ultrastructure in the central nervous system were realized through restoration of their internal membranes of normal morphological relations. Physiological regeneration of mitochondria in the brain of the gopher during functional activity of the animal was manifested in increased volume and number of the mitochondria and their cristae, as well as in their rearrangement, which is ap-

parently associated with increased transport of electrons and intensified enzymatic function. (auth)

38768 ON CORNEAL DAMAGE THRESHOLDS FOR CO_2 LASER RADIATION. Chang, Howard H. C.; Dedrick, Kent G. (Stanford Research Inst., Menlo Park, Calif.). Appl. Opt., 8: 826-7(Apr. 1969).

A gaussian shaped CO_2 laser beam operating at 10.6 μ was used to measure damage thresholds on the rabbit cornea at exposure times of 55 msec, 10 msec, and 3.5 msec. A three-dimensional heat flow equation is developed to take into account the transverse heat flow that is characteristic of a radiation image of finite size. (E.R.B.)

38769 LACK OF EFFECT OF X IRRADIATION ON BRAIN 5-HYDROXYTRYPTAMINE CONCENTRATIONS. Komesu, N.; Haley, Thomas J. (Univ. Of Hawaii, Honolulu). Contract AT (04-1)-GEN-12. Proc. West. Pharmacol. Soc., 11: 77-80(1968). (TID-24158).

It was previously reported that 2 hr after 1000-R whole-body x irradiation, the 5-hydroxytryptamine content of the rat hypothalamus was decreased. However, others found that, while 6000 and 12,000 R increased the brain content of 5-hydroxytryptamine in mice and rats, 3000 R did not. The combination of 8000 R and iproniazid or reserpine also resulted in an increase in brain 5-hydroxytryptamine. The fact that most investigators used a bioassay method which was subject to error from possible contamination of the extracts with other stimulant compounds led the present authors to reinvestigate the problem using a chemical method of analysis. Rats were given 600 or 1200 R of whole-body or 1200 R of head x irradiation. In addition, some received 40 mg/Kg of tetrabenazine, 3 mg/Kg of reserpine, or 40 mg/Kg of iproniazid daily for 10 days. Irradiation, whether whole body or head only, had no effect on the brain stem (including diencephalon, mesencephalon, hypothalamus, and medulla) concentration of 5-hydroxytryptamine. On the other hand, the 5-hydroxytryptamine-depleting drugs, tetrabenazine and reserpine, both drastically reduced the brain stem concentration of 5-hydroxytryptamine. The increase in brain stem 5-hydroxytryptamine concentration produced by chronic administration of the monoamine oxidase inhibitor iproniazid was similar to that reported earlier. The results indicated that the analytical method used to determine 5-hydroxytryptamine was sensitive enough to detect small changes in its brain stem concentration if radiation had produced them, which it did not. Thus, this neurohumoral agent probably plays no part in radiation-induced changes in brain electrical activity. (BBB)

38770 MUTUAL EFFECT OF 900 RAD OF GENERAL GAMMA-IRRADIATION AND SUBSEQUENT CUTANEOUS-MUSCULAR WOUND. Stajic, J.; Milovanovic, A.; Stojanovic, D. (Boris Kidric Inst., Vinca, Yugoslovia). Vojnosanit. Pregl., 24: No. 2, 78-82(1967). (In Slovak).

The combined effects of 900 rad whole-body γ irradiation and mild cutaneous-muscular wounds in different phases of development were examined in male albino rats. The lethality, healing rates, changes in body weight, and changes in the leukocyte count of peripheral blood were observed. Changes in body weight and leukocytes count of peripheral blood depended on the time interval between irradiation and wounding. It was concluded that the combined effect of irradiation and wounding in given conditions depends greatly on the chronological order of their association. (Bull. Sci) (TSS)

38771 THE EFFECT OF NICOTINIC ACID DERIVATIVES ON RADIOINDUCED INHIBITION OF MITOSIS IN EHRLICH ASCITES TUMOR CELLS. Kaufmann, Horst; Plaszek, Lothar; Tiemann, Wilram; Bartholomae, Hans-Joachim (Roentgeninstitut der Staedtischen Krankenanstalten, Essen). Arzneim.-Forsch., 18: 1579-82(Dec. 1968). (In German).

In continuation of earlier studies in which it was demonstrated that the reaction to irradiation is influenced by 7-[hydroxy-3-(N-2-hydroxyethyl-N-methylamino)propyl]-1,3-dimethylxanthine-pyridine-3-carboxylate (xanthinolnicotinate; Complamin), the effect of Complamin on the inhibition of mitosis induced by irradiation in Ehrlich ascites tumor cells was investigated in mice. In the first inhibition phase of mitosis, administration of Complamin shortly before irradiation caused the rate of mitosis to decrease more slowly than drug administration after irradiation or the decrease in the control group. This effect may be the consequence of a decreased radioinduced inhibition of the synthesis of nicotinamide adenine dinucleotide and adenosine triphosphate in the last phase of intermitosis. The duration of the mitosis depression after irradiation was prolonged by administration of Complamin before or after irradiation to a similar extent. (BBB)

38772 CHANGES IN MEMORY, ELECTROPHYSIOLOGY, NEUROCHEMISTRY, AND NEURONAL ULTRASTRUCTURE AFTER DEUTERON IRRADIATION OF THE BRAIN IN C57Bl/10 MICE. Ordy, J. M.; Samorajski, T.; Horrocks, L. A.; Zeman, W.; Curtis, H. J. (Cleveland Psychiatric Inst.). J. Neurochem., 15: 1245-56(Nov. 1968).

Changes in memory, electrocorticograms (ECoG), protein, DNA, RNA, neurotransmitters, enzyme activity, and neuronal ultrastructure were examined after deuteron irradiation of the brain in C57Bl/10 mice. Twenty animals served as sham-irradiated controls, while three irradiated groups received a dose of 500, 5000, or 10,000 rad covering an area of 9 × 5 mm over the dorsal surface of the brain and extending to a depth of 2 mm from the skull. The 10,000-rad group differed significantly in retention of spontaneous locomotor performance and dark maze exploration during a 16-month postirradiation period. Desynchronization with an overall amplitude reduction of both spontaneous and light evoked ECoG was observed in the 10,000-rad group. There was a dose-dependent decrease in protein, DNA, and RNA content but not in their concentrations. Brain irradiation resulted in a significant change in content as well as concentration of 5-hydroxytryptamine and in acetylcholinesterase activity both per brain and per g fresh weight. Morphologically, there was a significant reduction in brain and pituitary weight. Histochemical observations indicated a uniform and dose-dependent reduction in vascular alkaline phosphatase activity and a selective decrease in staining for cellular DNA and RNA in different regions of the irradiated tissue of the brain. Electron microscopic comparisons of nuclear and cytoplasmic changes indicated serration of some nuclear membranes in the 10,000-rad group, accumulation of glycogen, numerous phagocytes and formation of multilamellar intraneuronal membranes. Prominent synaptic changes were not observed in the remaining neurons within the irradiated tissue of the brain. It was concluded that deuteron irradiation of the central nervous system can be used for relating changes in such unique functions as learning and memory to subcellular and cellular changes in the specific regions of the brain. (auth)

38773 RNA OF LYMPHOCYTES IN THE BLOOD OF RABBITS INFECTED WITH HOG CHOLERA VIRUS IN COMBINATION WITH ACUTE RADIATION SICKNESS. Skimundris, V. S. Dokl. Vses. Akad. Sel'shokhoz. Nauk, No. 7, 34-6(July 1967). (In Russian).

Results are reported from studies on changes in the content of RNA in lymphocytes in the peripheral blood of rabbits exposed to acute x radiation following infection with hog cholera virus (HCV). Cytochemical methods were used to determine RNA in lymphocytes in blood smears stained with pyronine and methyl green. Following irradiation the number of lymphocytes was decreased significantly. Rabbits infected with HCV without preliminary irradiation showed an increase in the number of lymphocytes and a large quantity of RNA granules in the lymphocytes. The number of lymphocytes in infected, irradiated rabbits was decreased, but not as much as in noninfected, irradiated rabbits, while the number of RNA granules was decreased when compared to the number in infected, nonirradiated rabbits. (ATD) (TSS)

38774 ON THE QUESTION OF DIFFERENCES IN THE NUMBER OF ENDOGENOUS HAEMOPOIETIC TISSUE COLONIES IN THE SPLEENS OF IRRADIATED HAIRLESS AND HAIRED MICE. Vacek, A.; Davidova, Eva (Inst. of Biophysics, Brno). Folia Biol. (Prague), 15: 197-204(1969).

Survival, the number of endogenous (ESC) and exogenous (CFU) hematopoietic colonies, and ^{59}Fe incorporation in the spleen and femur were studied in hairless strain BFÚ and haired strain H and C57BL mice before and after x irradiation. High proliferative activity of hematopoietic spleen stem cells was found in hairless unirradiated mice compared with the haired strains. After irradiation, a greater number of ESC and CFU was observed in the hairless strain and ^{59}Fe incorporation into the spleen was also higher than in the irradiated haired strains. The possibility of chronic nonspecific stimulation of hematopoiesis in hairless mice, as a cause of raised ESC formation in the spleens of irradiated mice, is discussed. (auth)

38775 CURRENT TOPICS IN RADIATION RESEARCH. VOLUME V. Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons, Inc., 1969. 101p. $15.50.

The different areas of radiation research that are reviewed and discussed are as follows: molecular radiation biology (radiation response of biologically functional molecules), radiation chemistry of aqueous systems in the frozen state, the induction and repair of radiation damage in Chlamydomonas, system aspects of granulopoiesis and radiation effects, oxygen diffusion and oxygen depletion problems in radiobiology, and the oxygen effects in radiotherapy. Each topic discussed is thoroughly doc-

umented. Separate abstracts were prepared for each of the six sections for inclusion in NSA. (C.O.)

For abstracts of individual chapters see: 37986, 38616, 38617, 38750, 38881, and 38892.

38776 PECULIARITIES OF REACTION TO IRRADIATION OF THE ENTEROCHROMAFFINE SYSTEM IN WHITE RATS AND GUINEA PIGS. Pankratova, G. G.; Chernov, G. A. Byull. Eksp. Biol. Med., 67: No. 6, 115-17(June 1969). (In Russian).

The effects of irradiation on the state of the enterochromaffine system of white rats and guinea pigs were studied. The animals received the lowest absolutely lethal dose: rats—900 R, guinea pigs—700 R. Enterochromaffine cells were detected by histochemical argentaffine reaction. In the guinea pigs a continuous fall of enterochromaffine cells was seen all along the development of radiation sickness. In rats at the height of radiation sickness after 5 to 7 days there was a marked increase of the number of enterochromaffin cells, that at the moment of death of the animals fell to normal limits. Rats had pathologically increased cells of the giant type. (auth)

38777 EFFECTS OF X RAYS ON THE HEN OVULE AND FORMATION OF THE EGG. Brard, E. (College de France, Paris). Compt. Rend. Soc. Biol., 162: 1110-13(1968). (In French).

The evolution potention of the mature ovule in hens is not destroyed by irradiation at 600 R/week, but after fertilization, this same dose frequently inhibits the embryonic development in the egg. The lethal doses on the germ cells are in the neighborhood of this dose of 600 R/week. The germ cells are more sensitive to x rays than the female gamete. A similar observation can be made with the male gamete. Doses of 600 and 900 R/week do not affect the fertilization capacity of the spermatozoids. Doses of 900 R affect the formation of the egg shell. (tr-auth)

38778 CHANGES IN THE OVARIAN STRUCTURE AFTER LOCAL IRRADIATION. Gubareva, A. V. (Roentgen-Radiological Inst., Leningrad). Byull. Eksp. Biol. Med., 67: No. 5, 61-3 (May 1969). (In Russian).

Local x irradiation of one ovary of mice (dose 150 R), with screening of the entire body and the other ovary was not followed by a statistically significant increase of ovarian tumors. However, the latent period of tumor development in the screened ovary was statistically significantly shortened as compared to latent period for development of ovarian tumors in intact mice serving as controls. (auth)

38779 THE INFLUENCE OF ADMINISTRATION OF HOMOLOGOUS TISSUE SUSPENSIONS ON THE MORTALITY OF IRRADIATED MICE. Klemparskaya, N. N.; Shikhodyrov, V. V. Byull. Eksp. Biol. Med., 67: No. 5, 27-9(May 1969). (In Russian).

In experiments on white mice irradiated with 800 R of ^{60}Co γ rays it was shown that the subcutaneous administration of a 25% suspension of homologous tissues from the intestine, liver and kidneys 5 hours after irradiation showed no effect, neither did the injection of distilled water (a labial test) into the skin of the upper lip. (auth)

38780 BIPHASIC PATTERN OF THYMUS REGENERATION AFTER WHOLE-BODY IRRADIATION. Takada, Akikazu; Takada, Yumiko; Huang, Chester C.; Ambrus, Julian L. (Roswell Park Memorial Inst., Springville, N. Y. State Univ. of New York, Buffalo). J. Exp. Med., 129: 445-57(Mar. 1, 1969).

Whole-body x irradiation of mice with 300 or 400 R caused a precipitous fall in thymus weight, followed by an increase in the mitotic index and an almost complete restoration of thymus mass. This phase was followed by a secondary fall in thymus weight and gradual recovery. This secondary fall could be prevented by intravenous injection of bone marrow or shielding of the hind limbs during irradiation. The hypothesis is proposed that the thymus depends on the migration of cells from the bone marrow to the thymus for the maintenance of its cell population. (auth)

38781 EFFECT OF X RADIATION ON THE POTENTIAL DIFFERENCE OF FROG'S ISOLATED SKIN. Nadareishvili, K. Sh.; Sanaya, T. V. (Inst. of Physiology, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 53: 697-700(Mar. 1969). (In Russian).

X radiation at high doses resulted in the attenuation of frog's skin potential. The dose-effect curve comprises two kinds of deflection, thus emphasizing that it is not only active transport of sodium that accounts for the generation of frog's skin potential. (auth)

38782 HEPATIC CELLS OF IRRADIATED RATS: ACTION OF PHYTOHEMAGGLUTININ. Roveta, G.; Dragoni, G.; De Michell, G. (Univ., Pavia, Italy). Boll. Soc. Ital. Biol. Sper., 44: 1680(Oct. 31, 1968). (In Italian).

The effects of irradiation on the formation of nucleoli were studied in rats whole-body exposed to 400 R and 500 R on the hepatic region. The animals were sacrificed at various intervals and hepatic tissue was placed in contact with phytohemagglutinin. Only in the animals sacrificed a month after irradiation is there evidence of the blasting effect of phytohemagglutinin. (J.S.R.)

38783 EFFECT OF X-IRRADIATION ON THE TESTICLES AND OVARIES OF IMPUBERAL MICE. Milko, V. I.; Pilyavskaya, S. M. (Kiev Medical Inst.). Dopov. Akad. Nauk Ukr. RSR, Ser. B., No. 5, 455-8(May 1969). (In Ukrainian).

Gonocytes, undifferentiated cells, and spermatogonia, especially spermatogonia B were the most x-radiosensitive elements of a testicle. Oocytes of primordial follicles developing after birth were distinguished by a high radiosensitivity in an immature ovary. Correlation was not observed between radiosensitivity of the gonad cells and their mitotic activity. (auth)

38784 EFFECT OF TWO SUCCESSIVE IRRADIATIONS ON THE CELLULAR POPULATION OF THE CRYPTS OF LIEBERKUHN IN THE RAT. INFLUENCE OF CYSTAMINE. Simar, L. J.; Betz, E. H. (Univ., Liege). Compt. Rend. Soc. Biol., 162: 1233-7(1968). (In French).

The effect of two successive doses of x radiation separated by an interval of two or three days was investigated on the cellular population of the intestinal crypts of Lieberkuhn in the rat. A first irradiation of 500 R causes a protection relative to a second irradiation at the same dose. This protection is shown by a smaller depopulation or an earlier repopulation of the Lieberkuhn crypts. The delay separating the two irradiations is very important. If it is 48 hrs, the second dose is much more toxic than if the separation is 72 hrs. When the first irradiation is preceded by an injection of cystamine, the resumption of the mitotic activity is much earlier. (J.S.R.)

38785 EFFECT OF ERYTHROPOIETIN ON REGENERATION OF HEMATOPOIETIC STEM CELLS AFTER 5-FLUORouracil ADMINISTRATION. Reissmann, Kurt R.; Samorapoompichit, Sommart (Univ. of Kansas Medical Center, Kansas City). J. Lab. Clin. Med., 73: 544-50(Apr. 1969).

Female mice were injected intravenously with 140 mg of 5-FU per kilogram of body weight. One half of the mice received in addition 15 units of human urinary erythropoietin in three divided doses at 8, 16, and 24 hr after 5-FU administration. For measurement of colony-forming units (CFU), femoral marrow was collected on each of the 10 days following 5-FU injection. Nucleated cells were counted in a counting chamber. Five-tenths milliliter of each cell suspension, representing a suitable fraction of one femoral marrow, was injected in the tail vein of each of 25 lethally γ irradiated mice (975 rad whole-body radiation, ^{60}Co γ source). Ten days later the recipients were killed and the spleens fixed in Bouin's solution. Visible colonies on the surface of the spleen were counted and their number expressed as per one donor femur. Erythropoietin-sensitive stem cells were assayed in mice made polycythemic by 3 weeks' exposure at 300 to 340 mm Hg barometric pressure. Two days after their removal from the decompression chamber, the mice received 5-FU and erythropoietin as described. They were then divided into groups of 8 mice, and serial measurements of their erythroid response were made by injecting a test dose of one unit of erythropoietin per mouse in one group each on days three to nine after 5-FU. Each mouse received 0.5 μc ^{59}Fe 48 hr later, and ^{59}Fe incorporation was ascertained on heart blood collected 24 hr thereafter. Blood volume was calculated as 7% of body weight. The accelerated recovery of erythropoiesis after large doses of erythropoietin in 5-FU treated mice was found to be caused by a markedly accelerated regeneration of erythropoietin-sensitive stem cells (ESC). Erythropoietin had no effect upon regeneration of colony-forming units in 5-FU treated mice. It was concluded that erythropoietin either induced inflow of precursors into the ESC population or that it stimulated cell division of ESC. The lag between marrow injury and reappearance of proerythroblasts was attributed to a prescribed number of successive divisions each erythroid stem cell has to complete before its genome for differentiation can be fully expressed. (auth)

38786 EFFECTS OF RADIATION ON THE CAPACITY OF THE STEM CELL COMPARTMENT TO DIFFERENTIATE INTO GRANULOCYTIC AND ERYTHROCYTIC PROGENY. Hellman, Samuel; Grate, Helen E.; Chaffey, John T. (Harvard Medical School, Boston). Blood, 34: 141-56(Aug. 1969).

Different methods have been used to measure the survival fol-

lowing radiation of the hematopoietic stem cell pool. Two of these systems measure the stem cell pool by its ability to proliferate and differentiate into mature progeny. In both methods, irradiated recipient mice receive syngeneic bone marrow. A period of time is allowed for the transplanted progenitor cells to divide and differentiate, and then the progeny produced are assayed. Ability to form red blood cells is assessed by the amount of radioactive iron incorporated into newly formed erythrocytes. Capacity for granulocyte formation is measured by peripheral white blood cell counts following endotoxin stimulation. This latter is a granulocyte response and was shown to be a measure of the marrow granulocyte reserve. The pool as measured by its ability to produce erythrocytic progeny appears to be more sensitive initially than as measured by its ability to produce granulocytic progeny. Erythropoietic repopulating ability begins recovery more promptly than the granulopoietic. These effects appear to be due to the host milieu rather than any direct effect of radiation on the stem cells, resulting in initial conservation of granulopoiesis relative to erythropoiesis with subsequent compensatory recovery of erythropoiesis. Because of recent evidence suggesting a common stem cell, these results are interpreted as consistent with the notion that radiation affects not only stem cell proliferation, but also the direction and extent of differentiation. (auth)

38787 STUDY OF TUMORS PRODUCED BY SHOPE FIBROMA VIRUS IN ^{60}Co-γ IRRADIATED DOMESTIC RABBITS. Ono, Kohei (Osaka Univ.). Osaka Daigaku Igaku Zasshi, 20: No. 3-4, 21-9 (Apr. 1968). (In Japanese).

Shope fibroma virus was injected into rabbits 24-hr following whole-body exposure to 400 to 1200 R doses of ^{60}Co γ radiation. The injection site was treated with antibiotics and anti-inflammation drugs. The growth rate of virus-induced tumors was compared with those in non-irradiated hosts, using tissue cultures, fluorescent antibody tests, and complement fixation tests. The growth rate of tumors was more rapid in irradiated hosts and in many cases a secondary tumor, diagnosed histologically as fibrosarcoma, also developed. (NSA of Japan) (TSS)

38788 REGULARITIES OF LYMPHOCYTE MIGRATION IN REGIONALLY IRRADIATED MARROW. Scherbova, E. N.; Gruzdev, G. P. (Inst. of Biophysics, Moscow). Dokl. Akad. Nauk SSSR, 185: 935-7(Apr. 1969). (In Russian).

Quantitative concentration regularity of lymphocyte concentration in radiation injured marrow was studied using 210 white male rats (weighing 200 to 220 g) exposed to local posterior x irradiation of 25, 50, 75, 100, 200, 300, or 1000 R. The studies revealed that the reduction of lymphocytes in peripheral blood during exposure from 25 to 1000 R is of exponential character with $D_0 = 75 \pm 6$. A curve was developed for lymphocyte concentration in injured marrow as a function of the number circulating in the peripheral blood. The results indicated that the lymphocyte migration into injured areas resembles a filtration process with possible lymphocyte precipitation in marrow independent of their number in peripheral blood. (R.V.J.)

38789 THE EFFECT OF LOCAL IRRADIATION OF THE GONADS OF INFANTILE AND ADULT MALE RATS ON THE SURVIVAL AND REGENERATION OF REPRODUCTIVE ORGANS. Pecevski, Jugoslava; Malcic, Katica (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Strahlentherapie, 137: 493-8(Apr. 1969).

Testes of a rat irradiated on the first day of life do not show any sign of regeneration. Gonads of the adult rats exposed to doses of 600 R have an ability for spontaneous regeneration. High doses of x irradiation cause irreversible damages in the stem cells of spermatogenesis. Morphological changes in the epithelium do not show different kinds of damages but with the increasing doses, the interval for an appearance of degenerative changes in the testes diminishes. Local irradiation of the gonads effects survival and also causes a high percentage of normal sperm. (auth)

38790 EMBRYONIC DEVELOPMENT OF MICE UNDER THE INFLUENCE OF CONTINUOUS ^{60}Co GAMMA RADIATION DURING BLASTOGENEISIS, ORGANOGENESIS, AND FETAL PERIOD. Konermann, Gerhard (Univ., Freiburg i. B.). Strahlentherapie, 137: 451-66(Apr. 1969). (In German).

Mice embryos were exposed either continuously or with fractionated doses of cobalt-60 given daily. The total doses accumulated between conception and birth ranged from levels causing minor defects to amounts that were 100% lethal to the fetus. Comparison of the fractionated radiation procedure with continuous exposure reveals that the latter requires approximately 15 times higher doses to cause equivalent biological effects on the embryo. (H.B.G.)

38791 KINETICS OF INJURY AND REPAIR IN MONKEYS AND DOGS EXPOSED TO γ-RAY FRACTIONATION. Spalding, J. F.; Holland, L. M.; Johnson, O. S. (Los Alamos Scientific Lab., N. Mex.). Health Phys., 17: 11-17(July 1969).

Monkeys and dogs were exposed to γ-rays totaling 1048 Rads. The fractionation method was used to deliver 14 unequal doses at time intervals calculated according to an effective residual dose function deemed feasible for man in an emergency. Dogs survived the radiation exposures, but lethality in monkeys was greater than anticipated. The effective residual dose factors tested appeared to be over-optimistic for human use in an emergency. (auth) (UK)

38792 EFFECT OF IRRADIATION ON CELLS. RADIATION BIOLOGICAL AND NUCLEAR HEMATOLOGICAL PROBLEMS. Hajdukovic, S. (Univ., Liege); Szirmai, E. Med. Nucl.-Radiobiol. Lat., 11: 59-82(1968).

Data are reviewed from a number of studies on the effects of various doses of γ and x radiation on the morphology, survival, and ultrastructure of hematopoietic cells. Changes in the cell nucleus are emphasized. Studies of the effects of 700 R γ radiation on hematopoietic cells in chick embryos exposed during four stages of their development showed that primitive hematopoietic cells are more radiosensitive than mature cells. Chromosome abnormalities observed in human leukocytes exposed to mixed γ and neutron doses of about 430 Rad in the Vinca radiation accident are also reviewed. (C.H.)

38793 EFFECTS OF IRRADIATION ON SELECTION RESPONSE IN MICE. Womack, James (Abilene Christian Coll., Tex.); Bogart, Ralph. J. Hered., 59: 269-74(Sept.-Oct. 1968).

The relative effects of x irradiation on selection response in a production trait (28-day weight) and a fitness trait (litter size) were studied in closed lines of mice. Selection response, theoretically a product of selection intensity, phenotypic standard deviation, and heritability, was investigated relative to each of these component variables and the degree to which each is affected by irradiation. X irradiation (25, 50, and 100 R) was administered to both males and females immediately before pairing. No matings were made later than 14 days after irradiation so that only the effects of irradiation upon the postmeiotic stages of gametogenesis were studied. The lines receiving 50 and 100 R were all lost by the fourth generation of selection. An interaction of genetic and physiological factors was assumed to be responsible for the reduced fertility leading to the termination of these lines. Selection response for litter size was negative in five of the six irradiated lines. This was attributed to reduced selection differentials due to lower fertility and to reduced heritability due to physiological masking of the additive genes for litter size. Accumulation of deleterious recessive genes also may have played a role in reducing heritability in the irradiated lines. Selection response for 28-day weight was positive in four of the six irradiated lines, although less than in the nonirradiated controls in most cases. Three of the irradiated lines had realized heritability values greater than either of the controls. Some increase in usable genetic variance for 28-day weight was indicated, although reduced selection differentials prohibited increased selection response. (BBB)

38794 LATE EFFECTS OF RADIONUCLIDE DAMAGE. Moskalev, Yuri I.; Streltsova, V. N.; Buldakov, L. A. (Inst. of Biophysics, Moscow). pp 489-509 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

Internally deposited radionuclides can cause tumor and non-tumor delayed effects. Non-tumor effects included liver cirrhosis, pneumosclerosis, vascular damage, and endocrine disturbances. The types of induced tumors depended on which tissues were irradiated. Osteosarcomas, leukemias, liver tumors, and pituitary tumors were observed in rats receiving radionuclides as adults. The lowest average bone doses at death in rats with osteosarcomas were: ^{90}Sr = 800 Rads, ^{144}Ce = 2100 Rads, ^{147}Pm = 800 Rads, but ^{239}Pu = 57 Rads. The ^{239}Pu was given orally, 0.5 μCi each day in citrate solution: each of these other radionuclides was given in a single intraperitoneal injection in chloride solution. No osteosarcomas were observed in 1529 injected lower-level rats, or in 722 control rats. A leukemia incidence of 6.1% was observed in 82 rats injected with 10 μCi ^{90}Sr/kG with a resulting marrow dose of 530 Rads. Higher incidences were observed in some of the higher-dose groups. The incidence of leukemia was 1.7% in 402 controls. Liver tumors occurred in 3.4% of 177 rats injected with 500 μCi ^{144}Ce/kG with a resulting liver dose of 7900 Rads. Higher incidences occurred at higher-dose groups. The incidence of liver tumors was 1.5% in 337 controls. Pituitary tumors occurred in 8.3% of 84 rats injected with 5 μCi ^{90}Sr/kG (pituitary dose = 210

Rads) and in 10.2% of 59 rats injected with 5 μCi ^{144}Ce/kG (pituitary dose = 120 Rads). The incidence was 1.5% in 337 controls. In rats, pituitary tumors may occur at even lower doses. (auth)

38795 BIOCHEMICAL CHANGES INDUCED BY INTERNALLY DEPOSITED RADIONUCLIDES IN BEAGLE DOG BLOOD: A STATISTICAL STUDY. Berliner, David L.; Stevens, Walter; Nabors, Charles J. Jr.; Maxwell, Richard E. (Univ. of Utah, Salt Lake City). pp 471-88 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

Biochemical studies on the effects of internally deposited radionuclides in Beagle dogs were pursued for the past 13 yr. The radionuclides used in this study were ^{239}Pu, ^{228}Ra, ^{226}Ra, ^{228}Th, and ^{90}Sr. Certain biochemical parameters were subjected to multivariate regression analysis. These were serum glutamic pyruvic transaminase, serum alkaline phosphatase, serum phosphorus, total serum protein, serum albumin and serum globulins. Changes with age in control animals were evaluated statistically, and these data are presented in this paper. Control animals showed increases in blood levels of alkaline phosphatase, total serum proteins, and total serum globulins with increasing age. Changes in the biochemical parameters studied were related to the individual radionuclide with respect to the site of its deposition, the dosage, and the elapsed time after injection. (auth)

38796 LEUKOCYTE DEPRESSION IN BEAGLES INJECTED WITH ^{226}Ra OR ^{239}Pu. Dougherty, Jean H. (Univ. of Utah, Salt Lake City); Rosenblatt, Leon S. pp 457-70 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

Leukocyte changes over the first yr post-injection were studied in Beagles given ^{226}Ra or ^{239}Pu. The probit technic was utilized to linearly relate response to dose (injected microcuries per kilogram). The regression lines for ^{226}Ra and ^{239}Pu were found, generally, to be parallel for total leukocytes, segmented polymorphonuclears (seg. pmns), lymphocytes, and eosinophils, indicating that the shapes of the dose-response curves for these radionuclides on the hematopoietic system were similar. Median effective doses (ED_{50}) producing 50% reduction in WBC and segmented pmns increased with time, indicative of recovery, while the lymphocytes and eosinophils showed no recovery during the first yr. The ED_{50} curves were linear for ^{239}Pu but not for ^{226}Ra. This finding may be related to the difference in pattern of retention. Toxicity indices, i.e., the ratio of injected μCi Ra/μCi Pu for 50% cell depression, were computed. They showed that ^{239}Pu was approximately four to eight times as effective as ^{226}Ra in depressing WBC and segmented pmns to the same level, but only two to four times as effective in the case of lymphocytes. (auth)

38797 VASCULAR CHANGES IN BONES FOLLOWING BONE-SEEKING RADIONUCLIDES. Jee, W. S. S.; Bartley, M. H.; Dockum, N. L.; Yee, J.; Kenner, G. H. (Univ. of Utah, Salt Lake City). pp 437-55 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

Vascular changes in bones from Beagles burdened with bone-seeking radionuclides were studied by point counting microphotographs magnified 70 times of areas of compacta and spongiosa of India ink-gelatin injected metatarsi. Significant vascular reduction occurred in the compacta (injected dose, days post injection, and accumulated dose) with 1.1 μCi/kG, 1900 days, and 2300 Rads for ^{226}Ra; 0.096 μCi/kG, 2200 days, and 350 Rads for ^{239}Pu; 0.17 μCi/kG, 2500 days, and 500 Rads for ^{228}Ra; 0.032 μCi/kG, 1900 days, and 250 Rads for ^{228}Th; and 100 μCi/kG, 1000 days, and 8000 Rads for ^{90}Sr. One dog receiving 0.005 μCi ^{228}Th/kG had decreased vascularity after 2159 days and 46 Rads. The lowest injected doses in μCi/kG with vascular depression in spongy bone (metatarsal metaphysis) were 1.1 for ^{226}Ra, 0.016 for ^{239}Pu, 0.17 for ^{228}Ra, 0.019 for ^{228}Th, and 32 for ^{90}Sr. Linear vessels per unit area (mm/mm^2) was the most sensitive measurement of depressed vasculature followed in order of decreasing sensitivity by percent of vessels normalized to bone, to area, and to marrow. (auth)

38798 OSTEOSARCOMAS INDUCED IN MICE BY FBJ VIRUS AND ^{90}Sr. Finkel, Miriam P.; Biskis, Birute O. (Argonne National Lab., Ill.). pp 417-35 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

Mice were treated with FBJ virus at birth and with ^{90}Sr as weanlings, young adults, or when mature to determine whether the actions of these two agents, both oncogenic for mouse bone, were independent. FBJ-induced and ^{90}Sr-induced osteosarcomas were tabulated as they appeared on weekly roentgenograms, and they were classified on the basis of their radiographic characteristics. FBJ tumors occurred most frequently between 50 and 110 days and least frequently, probably because of immunity, between 150 and 300 days. ^{90}Sr tumors appeared first about 180 days after injection and increased in number rapidly thereafter. In some situations when the two oncogenic agents were given to the same animal, ^{90}Sr partially inhibited the FBJ tumors, but the influence of pretreatment with virus on the incidence of ^{90}Sr tumors was even more striking. Virus-inoculated mice developed ^{90}Sr tumors sooner than uninoculated mice; however, when virus-treated mice were given ^{90}Sr at 28 days of age, the total number of ^{90}Sr tumors was only 20% of expected. This decrease did not occur when ^{90}Sr was given to adult animals. The incidence pattern of osteosarcomas resulting from treatment with both FBJ virus and ^{90}Sr suggests that immune processes are involved and that radiostrontium induces malignant change by inactivating an inhibitor of virus production, thereby permitting the replication of viral components normally present in mouse bone. (auth)

38799 RADIUM-INDUCED MALIGNANT TUMORS IN MAN. Finkel, Asher J.; Miller, Charles E.; Hasterlik, Robert J. (Argonne National Lab., Ill. Argonne Cancer Research Hospital, Chicago). pp 195-225 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

The incidence of radium-induced malignant tumors and blood dyscrasias was related to current or preterminal radium burden measurements and to retrospective estimates of maximum radium burdens for a series of 293 persons, most of whom acquired radium burdens in the period 1918 to 1933. The 46 malignant diseases included 23 bone sarcomas, 16 neoplasms of the skull (principally mastoid and paranasal air cell carcinomas), and seven leukemias and aplastic anemias. Retrospective estimates of maximum radium burdens were made by application of the appropriate power function for ingestion or for multiple injections. The power function parameters used here ($a = 0.30$ and $b = -0.44$) were recently derived by an analysis of data from long-term studies on eight patients for whom suitable data were available. The lowest estimated maximum radium burden for the bone sarcoma cases was 6.72 μCi, and that for carcinoma of the maxilla was 1.23 μCi. The comparable value for radium-attributed leukemias and other blood dyscrasias was over 50 μCi. Based on the estimated maximum initial burden, these data imply at least a 12-fold margin of safety in the maximum permissible level for internally deposited radium. (auth)

38800 RADIATION-INDUCED BONE CANCER IN BEAGLES. Mays, Charles W.; Dougherty, Thomas F.; Taylor, Glenn N.; Lloyd, Ray D.; Stover, Betsy J.; Jee, Webster S. S.; Christensen, William R.; Dougherty, Jean H.; Atherton, David R. (Univ. of Utah, Salt Lake City). pp 387-408 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

Osteosarcomas were the chief cause of death in adult Beagles injected intravenously with bone-seeking radionuclides in citrate solution. The effectiveness of these nuclides depended on the type of radiation emitted and where this radiation was absorbed. Alpha radiation was more effective than β radiation, and the α-emitters that deposit on bone surfaces were more effective than those that deposit throughout bone volume. For death with osteosarcomas 8 yr after injection, values for RBE (relative biological effectiveness) based on the average skeletal doses in Rads a yr before death and relative to ^{226}Ra = 1 were: ^{239}Pu = 6; ^{228}Th = 8; ^{228}Ra (MsTh) = 2.5, and ^{90}Sr = 0.07 to 0.24. (auth)

38801 OSTEOSARCOMAS AS RELATED TO TISSUE DISTRIBUTION OF MONOMERIC AND POLYMERIC PLUTONIUM IN MICE. Rosenthal, Marcia W.; Lindenbaum, Arthur (Argonne National Lab., Ill.). pp 371-86 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

The long-term effects of intravenously injected polymeric plutonium (about 66% ultrafiliterable) and of monomeric plutonium (93% ultrafiliterable) were compared in adult CF #1 female mice, using the bone burden of plutonium 15 days after injection as the basis of reference. Two levels of polymeric plutonium in the total

skeleton (0.015 and 0.0087 μCi) and three of monomeric plutonium (0.025, 0.012, and 0.0058 μCi) were compared; the lower levels in each case resulted from DTPA therapy. Interpolation of the results, to enable comparison of the effects of equal amounts of plutonium in the bone, showed that mice injected with monomeric plutonium, compared to those with polymeric plutonium, began dying earlier with osteosarcomas and had about twice as high an incidence of osteosarcomas (twice as many mice with tumors and more tumors per mouse). The higher concentration of monomeric plutonium on bone surfaces is considered primarily responsible for these differences. Other possible factors are also discussed. (auth)

38802 LONG-TERM BIOLOGICAL DAMAGE FROM ^{239}Pu AND ^{241}Am IN RATS. Taylor, David M.; Bensted, John P. M. (Royal Cancer Hospital, Sutton, Eng.). pp 357-70 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

Comparison of the long-term biological damage produced in rats by intravenous injection of ^{239}Pu or ^{241}Am showed that ^{241}Am was much less effective than ^{239}Pu for the induction of bone tumors. Injections of 2.5 μCi or 7 μCi ^{241}Am/kG produced bone tumors in 21 and 47% of the animals respectively, compared with 80% in animals given 2.9 μCi ^{239}Pu/kG. A few soft tissue lesions, including leukemia, were observed in all groups of rats. It is suggested that the differing incidence of bone tumors produced by ^{239}Pu and ^{241}Am is due to differences in the mechanisms by which these nuclides are deposited in bone. The possible role of sialo- or mucoproteins in the binding of ^{239}Pu and ^{241}Am in bone is discussed. (auth)

38803 ^{90}Sr IN THE RABBIT: THE RELATIVE RISKS OF OSTEOSARCOMA AND SQUAMOUS CELL CARCINOMA. Vaughan, Janet; Williamson, Margaret (Churchill Hospital, Oxford). pp 337-54 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

Experiments are described in which ^{90}Sr was injected into rabbits of different age groups. Carcinomas of the external ear occurred within 22 months in 2-day-old rabbits given 500 μCi ^{90}Sr/kg; no osteosarcoma was seen. Rabbits aged 6 weeks given the same dose and killed after 6 months developed osteosarcoma. An ear carcinoma was only seen in one rabbit surviving 9 months. All rabbits aged 6 weeks given a low injection dose, 50 to 200 μCi/kg, that lived as long as 60 months developed carcinomas of the ear but occasional osteosarcoma also occurred. In rabbits at least a year old when injected with high doses of ^{90}Sr, only tumors of the jaw and spine were found but no tumors in the ears or long bones. No animal in this age group, however, was allowed to survive longer than 38 months. It is suggested that the pattern of turnover rate of ^{90}Sr in different bones, affecting as it does the achievement of an appropriate accumulated dose, to cells capable of proliferative activity in osteogenic or epithelial tissue, determines which type of tumor occurs most commonly. This pattern is dependent upon many variables, such as age and the amount of ^{90}Sr injected. It is probable that some of the same factors may explain the high incidence of carcinomas in radium patients. The occurrence of leukemia is not discussed. (auth)

38804 SOFT-TISSUE TUMORS IN INTERNALLY IRRADIATED BEAGLES. Taylor, G. N.; Dougherty, T. F.; Shabestari, L.; Dougherty, J. H. (Univ. of Utah, Salt Lake City). pp 323-36 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

In Beagles injected in young adulthood with the indicated radionuclides, it appeared that the following 3 soft-tissue tumor types were induced: bile duct tumors (from ^{239}Pu); intraocular melanomas (from ^{226}Ra and ^{228}Ra); and carcinomas of the head sinuses (from ^{239}Pu, ^{226}Ra, and ^{90}Sr). Each of the foregoing tumors occurred after long latent periods and arose from tissues that were irradiated rather heavily. Surprisingly, the observed hematopoietic tumors did not appear to be radiation induced. (auth)

38805 ^{90}Sr-INDUCED NEOPLASIA: A SELECTIVE REVIEW. McClellan, R. O.; Jones, R. K. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). pp 293-322 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

Selected studies on the late neoplastic effects of ^{90}Sr were reviewed with special emphasis on both the complementary and conflicting nature of results obtained in several species with different exposure patterns. In studies conducted in seven different species; mouse, rat, rabbit, dog, monkey, swine, and sheep using intravenous, intraperitoneal, subcutaneous, inhalation, and oral routes of administration, in single or multiple doses, the effect common to all studies was the development of an increased incidence of osteosarcoma. In a large number of studies an increased incidence of hematopoietic tissue neoplasms was observed. In a few studies vascular and epithelial neoplasms were increased in incidence. Osteosarcomas were observed in highest incidence following single doses of ^{90}Sr that produced a high initial dose-rate followed by protracted low-level irradiation. Hematopoietic tissue neoplasms were observed in highest incidence in studies with continuous intake of ^{90}Sr at high levels starting early in life that produced gross hematologic alterations in the majority of the animals prior to diagnosis of leukemia. (auth)

38806 HEMATOPOIETIC CHANGES IN BEAGLES FED ^{90}Sr. Bustad, L. K.; Goldman, M.; Rosenblatt, L. S.; McKelvie, D. H.; Hertzendorf, I. I. (Univ. of California, Davis). pp 279-91 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

Hematopoietic changes in Beagles maintained on ^{90}Sr-containing diets for their first 1.5 yr of life are summarized. At average bone dose-rates up to 6 rads/day in seven treatment levels (ranging from 0 to 12 μCi ^{90}Sr fed/day), no significant alterations were noted in serum chemical tests. A persistent dose-related leukocyte depression was noted (primarily of neutrophils), that reached 50% at the highest feeding levels. There was no marked depression of erythrocytes. A probit analysis, fit to the data, provided a measure of dose effectiveness. Erythrokinetic studies with ^{59}Fe indicated no ^{90}Sr effects on plasma iron disappearance rate ($T_{\frac{1}{2}}$ 80 min), erythrocyte production rate, or erythrocyte life-span (104 days). In addition, the distribution of hematopoietic centers, as shown by a ^{52}Fe-positron camera survey, appeared normal. A thrombocyte depression was noted at the two highest levels of ^{90}Sr treatment. Eleven dogs, 1 to 3.5 yr old, manifested myeloid leukemia; these dogs were fed the two highest ^{90}Sr concentrations and they exhibited a terminal anemia. (auth)

38807 THE EFFECT OF PULSED, SHORT WAVES ON ALVEOLAR HEALING. King, Donald R.; Hathaways, John W.; Reynolds, Donald C. (Georgetown Univ., Washington, D. C.). J. D. C. Dent. Soc., 43: 15-19(Feb. 1968).

The effect of pulsed short-wave radiation on alveolar wound healing in dogs was studied. The machine used was a specially developed, pulsed, high-frequency short-wave generator which delivered short bursts of energy. Each burst was 65 μsec long. The period between each burst (1665 μsec) allowed for dissipation of heat in the tissues. Ten min exposures each day at 600 cps frequency were given. Histologic preparations of animals sacrificed at 3 days showed that the alveoli in both treated and control dogs were filled with clotted blood, but there was considerably more inflammatory infiltrate in the treated sections. This was seen primarily in the crestal one-half of the alveolus and consisted of neutrophils and a few lymphocytes. Sections stained for collagen showed that more collagen formed in the treated animal. Sections at 5 days showed more fibrous connective tissue in relation to clot in the treated animal than the control. Small areas of osteoid were seen in the treated animal. None was seen in the control. Capillary budding was more extensive and there was more collagen present in the treated animal. Sections at 8 days showed that bone had begun to form in the base of all alveoli. It was concluded that pulsed high-frequency short-wave therapy increased the inflammatory response and the rate of deposition of collagen in dog alveoli during the initial healing phase. (BBB)

38808 INDUCTION OF INTRAVASCULAR COAGULATION AND RENAL CORTICAL NECROSIS IN RABBITS BY SIMULTANEOUS INJECTION OF THOROTRAST AND ENDOTOXIN. Seeler, Ruth A.; Forman, Edwin N.; Bolger, Jane F.; Abildgaard, Charles F.; Schulman, Irving (Univ. of Illinois, Chicago). Brit. J. Haematol., 16: 501-5(May 1969).

Thorotrast was used in developing a reliable experimental model for the study of intravascular coagulation. By the use of simultaneous injections of Thorotrast and endotoxin, apart from the saving in time, this model had the advantage of initiating the intravascular clotting from a true baseline state. Preparation of rabbits with 6 ml/Kg of Thorotrast, administered intravenously, permitted the induction of intravascular clotting and the production of renal cortical necrosis with simultaneous injections of Escherichia coli endotoxin. With this dose of Thorotrast, a dose-response relation was observed between the fall in fibrinogen after

4 hr and doses of endotoxin ranging from 5 to 50 μg/Kg body weight. With such preparation, renal cortical necrosis occured in 46% of animals receiving 10 μg/Kg of endotoxin and increased to 80% in animals receiving 100 μg/Kg. Thorotrast preparation with 3 ml/Kg permitted intravascular clotting to occur with a single injection of endotoxin administered simultaneously. However, no correlation between endotoxin dose and fibrinogen depletion was observed and renal cortical necrosis developed only with relatively high doses of endotoxin. (BBB)

38809 THE EFFECT OF NEONATAL X IRRADIATION ON THE ACCUMULATION OF ^{3}H BY THE CENTRAL NERVOUS SYSTEM OF THE RAT FOLLOWING INJECTION OF ^{3}H-5-URIDINE. Cohan, Stanley L.; Ford, Donald H. (Downstate Medical Center, Brooklyn). Acta Neurol. Scand., 45: 53-62(1969).

The heads of newborn rats were exposed to 100 or 200 R of x irradiation within 12 hr of birth, and at 1 or 4 weeks of age, were injected with ^{3}H-uridine to investigate changes in metabolism of RNA in the central nervous system ½ to 4 hr later. In the 1-week-old rat, cerebellum had the highest level of radioactivity due to ^{3}H, followed in order by the cerebrum, diencephalon, brain stem, and hippocampus. There were no significant differences in radioactivity in the brain components at 4 weeks of age. Furthermore, the amount of radioactivity was significantly lower in each of the brain parts at 4 weeks of age as compared to those of the 1-week-old rats. These differences did not appear to reflect differences in plasma concentration of ^{3}H, but rather the results of the higher concentration of neurons in the younger rats, and the higher level of RNA synthetic activity in the nerve cells of the younger rats. Irradiation caused a significant depression in ^{3}H in the brain parts of 1-week-old rats, but by 4 weeks of age there were no significant differences between control and irradiated animals. The cerebellum of 1-week-old rats was the most radiosensitive brain part studied, having the greatest depression in accumulation of ^{3}H following irradiation. Depression in ^{3}H levels was greater after 200 R than 100 R x irradiation to the cerebellum, but not the other brain parts. The relatively greater radiosensitivity of the cerebellum may result from the relative immaturity of the rat brain at birth. (BBB)

38810 EFFECTS OF PROTEIN DEPRIVATION OF THE ERYTHROPOIETIC REPOPULATION FROM A SHIELDED FEMUR IN IRRADIATED MICE. Scaro, J. L. (Univ. Nacional de Tucuman, San Salvador de Jujuy, Argentina). Rev. Espan. Fisiol., 25: 119-24(June 1969). (In Spanish).

The effects of protein deprivation on the course of the endogenous erythropoietic restoration from a shielded femur in heavily irradiated mice were studied. The animals were given 150-rad whole-body x irradiation that was followed by 750 rad with a hind limb shielded. The ^{59}Fe uptake capacity in the shielded and unshielded femur, and in the spleen as well, was used as a criterion of erythropoietic recovery. On day 7 to 8 the animals fed a normal diet showed a clear recovery in the shielded bone marrow followed on day 9 to 11 by a striking recovery in the spleen. The daily injection of erythropoietin caused only an increase in these values without changes in the timing of erythroid repopulation. Dietary protein deprivation caused a change in this pattern of response. Although the shielded femur followed a similar course of recovery and could respond to erythropoietin stimulation, a lack of restoration of ^{59}Fe uptake capacity was observed in the unshielded areas that was particularly noticeable in the spleen. This lack of recovery in the heavily irradiated areas was interpreted as reflecting damage caused by protein depletion on the emigrating, colonizing, or differentiating potentials of stem cells remaining viable in the shielded bone marrow. (BBB)

38811 OCULAR INJURY FROM CO_2 LASER IRRADIATION. Geeraets, Walter J. (Medical Coll. of Virginia, Richmond); Fine, Ben S.; Fine, S. Acta Ophthalmol., 47: 80-92(1969).

Lesions produced in the rabbit eye by CO_2 laser irradiation are described. At the CO_2 laser wavelength (10.6μ), biological structures, transparent for the visible spectral range (400 to 750 nm), become opaque. About 67% of the incident energy of the CO_2 laser energy is absorbed in the first 10 μ of tissue with which it interacts whereas atmospheric attenuation is relatively low in comparison with that at wavelengths of the visible spectra region. These characteristics of CO_2 laser radiation may result in severe ocular injury primarily involving the cornea and deeper within the anterior segment of the eye, depending upon the energy and power densities and distribution on the cornea. Power densities incident on the cornea ranged from 9 to 20 W/cm. Most severe damage occurred within the exposed cornea with central ulcerations and perforations and with extensive thickening of the cornea in regions adjacent to the central defects. Iris changes were mild. The lenses of the exposed eyes showed changes that in the early stages postirradiation seemed to be restricted to the anterior lens capsule and cortex. However, later biomicroscopic observations (9 months postirradiation) revealed lens changes involving the posterior cortex as well without having resulted in marked cataractous changes. The late clinical findings, a corona of fine dustlike opacities within an optically hazy demarcation zone within the anterior, peripheral, and posterior cortex itself, resemble fine opacities that were observed in the rabbit lens after low dose x irradiation. (BBB)

38812 MORPHOLOGICAL CHANGES OF METABOLIC DISTURBANCES IN THE HEART IN LOCAL AND TOTAL IRRADIATION IN EXPERIMENT. Lushnikov, E. F. (Inst. of Medical Radiology, Moscow). Med. Radiol., 14: No. 7, 65-70(July 1969). (In Russian).

The pertinent literature data relative to the effect of ionizing radiation on the heart are summarized. The facts demonstrate that recent opinions on the radioresistance of the cardiac muscle require revision, since there occurs energetic and plastic exchange, revealed by modern morphological methods. (auth)

38813 EFFECTS OF X IRRADIATION ON SIZE OF LITTERS BORN TO FEMALE MICE IRRADIATED AT VARIOUS STAGES OF ESTROUS CYCLE. Womack, James; Bogart, Ralph (Oregon Agricultural Experimental Station, Corvallis). Int. J. Fert., 14: 130-40(Apr.-June 1969).

The relative effects of x irradiation on females in different stages of estrus were examined, along with the relative radiosensitivity of the male and female genital systems. Males and females between 60 and 74 days old were exposed to either 0, 25, 50, or 100 R of whole-body x irradiation. Matings were made at random immediately after treatment, with each male caged with 3 females for 2 weeks. This enhanced the probability that sperm in the postmeiotic stages at the time of irradiation were involved in the matings. The female germ cells were treated as mature oocytes since females must be irradiated as fetuses to expose oogonia. Litter size was measured as the number of live mice born in the first litter produced by each female. The histology of certain endocrine glands was also studied. There was no significant difference in litter sizes from animals treated at the various radiation levels, but there was a reduction in number of litters born in the irradiated lines. Litters born to parents mated during the first week after receiving 50 R averaged 9.6 mice, while those born to parents mated in the second week averaged 7.0 mice. Thus, litters born to mice which mated during the first week after receiving 50 R (and 100 R) were slightly above the over-all mean, while litters born to mice that were irradiated with 50 R (and 100 R) 1 to 2 weeks before mating were significantly reduced. A control line in which only the males received 100 R failed to show this effect. Females in metestrus at time of irradiation produced large litters, while females irradiated with 50 and 100 R 1 full estrous cycle before mating produced significantly smaller litters. Eight months after irradiation, spermatogenesis in males receiving up to 100 R appeared histologically normal. Ovaries from females receiving 25 R showed a significant reduction in developing ova and corpora lutea, while ovaries from females receiving 50 and 100 R were completely atretic and histologically sterile. No other significant endocrine effects with doses of up to 100 R were found. (BBB)

38814 RADIATION DEPIGMENTATION OF MOUSE HAIR: EFFECTS OF MOUSE STRAIN. Potten, Christopher S. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Brit. J. Dermatol., 81: 289-98(Apr. 1969).

In mice of various coat-color genotypes, differences in radiosensitivity of hair depigmentation were demonstrated. The x-radiation-induced depigmentation response of seven types of mice was studied by counting the number of follicles without pigmentation. The response varied slightly among genotypes, Strong F (dilute brown chinchilla spotted) being the most sensitive. The D_0 value (increment of dose required to reduce the fraction (f) of follicles with melanocytes to $f \times e^{-1}$ (or 0.37 f) once the experimental region of the curve was reached) was 334 rad in this strain compared to 516 rad in the C57Bl strain. The sensitivity differences cannot be attributed to differences in the number of precursor cells in zigzag follicles. However, the overall precursor pool may vary due to changes in the relative proportions of the follicle types in different genotypes or strains. (BBB)

38815 STUDIES OF THE $^{14}CO_2$ EXPIRATION FOLLOWING INTRAGASTRIC ADMINISTRATION OF ^{14}C-GLYCERYL-TRIOLEATE AND ^{14}C-OLEIC ACID IN RATS AFTER WHOLE BODY X-IRRADIATION. Glaubitt, D.; Wulff, K.; Ulrich, I. (Univ., Hamburg). Fortschr. Geb. Roentgenstr. Nuklearmed., 108: 790-4(June 1968). (In German).

Total body radiation of 600 to 800 R of male Wistar rats lead to a reduction in $^{14}CO_2$ production following intragastric admin-

istration of ^{14}C-triolein and an increase after ^{14}C-oleic acid. Total body radiation produces a reduction in carbon dioxide production. Specific radioactivity in the exhaled air of irradiated rats declines after the administration of ^{14}C-triolein and increases after ^{14}C-oleic acid. (auth)

38816 THE EFFECT OF RADIATION ON THE GROWTH OF VERTEBRAE IN THE TAILS OF RATS. II. SPLIT DOSES OF X-RAYS AND THE EFFECT OF OXYGEN. Dixon, B. (Hammersmith Hospital, London). Int. J. Radiat. Biol., 15: 215-26(1969).

Vertebrae in the tails of rats have been irradiated with single and split doses of x rays under reduced, normal and increased conditions of oxygenation. Split doses were less effective in stunting vertebral growth than single doses. This sparing effect was dependent on the time between fractions and the size of the total dose, but independent of vertebral oxygenation. These results are accounted for in terms of the recovery of epiphyseal cartilage cells from sublethal injury. It is suggested that with x rays the survival curve for epiphyseal cells in situ has a large shoulder followed by an exponential part. (auth)

38817 REPRODUCTIVE PERFORMANCE OF WISTAR RAT FOLLOWING INTERNAL ^{60}Co IRRADIATION AT LOW DOSE LEVELS. Srivastava, Pratap N.; Rao, A. Ramesha (Univ. of Rajasthan, Jaipur, India). Strahlentherapie, 137: 634-6(May 1969).

When young adult male and female albino rats are injected with 10, 20, and 30 μCi of ^{60}Co subcutaneously and allowed to breed, they do not show any changes in their litter size at least for five successive litters. The litters do not show any mortality or deformities. (auth)

38818 KINETICS OF EHRLICH ASCITES TUMOR CELLS IN MICE FOLLOWING EITHER SINGLE OR FRACTIONATED WHOLE-BODY IRRADIATION. COMPARISON BETWEEN 200 kV X-RAY, ^{60}Co, AND ^{137}Cs GAMMA RADIATION. PART II. Chone, Bruno; Blind, Edmund; Thauer, Detlef (Univ., Heidelberg). Strahlentherapie, 137: 554-63(May 1969). (In German).

The morphological modifications and cellular proliferation kinetics were studied in mice, after EAT and irradiation with unique or fractionated doses of different radiation qualities. The unique dose ranged between 100 and 700 R, the fractionation schemes were 3×100 to 400 R or 2×600 R. The radiation sources were either a 200 kV x-ray apparatus, or a telecobalt or telecesium source. One hour before irradiation, ^{3}H-thymidine was injected intraperitoneally (2 μCi/g body weight). The results were examined from the quantitative and qualitative point of view, and the efficiency of the different radiation qualities compared. (auth)

38819 REACTION OF BLOOD CELLS IRRADIATED UNDER HYPERBARIC OXYGEN IN A HIGH PRESSURE CHAMBER. (ANIMAL EXPERIMENTS). Teske, Hans-Juergen; Braeumer, Hans-Juergen (Ruhr-Univ., Essen). Strahlentherapie, 137: 572-7(May 1969). (In German).

Rats were exposed to 200 R whole-body x radiation in a hyperbaric oxygen chamber. Various groups were exposed under oxygen pressure from one atmosphere to five atmospheres. Changes in the count of erythrocytes, leukocytes, and thrombocytes depended only on the radiation dose but not on the oxygen pressure. (H.B.G.)

38820 ERYTHEMA AND CIRCULATION IN X-IRRADIATED RABBIT SKIN. Wiskemann, A.; Reich, H. (Univ.-Hautklinik, Hamburg). Z. Haut- Geschlechtskr., 42: 621-4(Aug. 1, 1967). (In German).

Irradiation reactions of rabbit skin were measured after exposure to doses of 2000 R over a 3 cm^2 area of the ear. Hyperemia without increased blood flow was first observed 8 days after irradiation, followed within 8 days by sharply increasing circulation. There was no evidence of circulatory decreases produced by edema. Vascular permeability in the irradiated area was increased within 80 min after irradiation, but this was not evident 14 days after irradiation. Erythema and increased blood circulation were measured photometrically and by heat transmission, and were greatest at the surfaces of the irradiated skin areas. The increased circulation in the irradiated skin reached a maximum within 6 days, but quickly returned to normal, with the appearance of exudation. The circulation in the atrophic irradiated skin was still increased in some of the animals $4\frac{1}{2}$ months after irradiation, and in no case was it any lower than in unirradiated skin. (BBB)

38821 TRYPANOSOMA CONGOLENSE: INFECTIVITY FOR WHITE MICE. Irfan, M. (West Pakistan Agricultural Univ., Lyallpur). Exp. Parasitol., 23: 254-9(Oct. 1968).

Swiss mice are susceptible to Trypanosoma congolense. Intact, splenectomized, irradiated, or irradiated and splenectomized mice showed no variation in susceptibility to infection. The incubation period varied from 4 to 19 days. The incubation period for x-irradiated mice (no doses are stated) was 10 days and they died 43 to 106 days later. The highest concentration of trypanosomes in the blood during life was 4+ (relative concentrations being recorded as ± to 6+). In irradiated and splenectomized mice the incubation period was 7 days and they died 42 days later. The highest concentration of trypanosomes in the blood during life was 4+. Different concentrations of trypanosomes in the inoculum used did not affect the course of the disease. The life span of individually infected mice varied from 4 days to 342 days, but 69% died between 50 and 342 days. The number of trypanosomes in the blood during the early migratory stages varied from ± to 4+, but in 97% of the cases the range was within ± to 2+. The highest concentration of trypanosomes during the course of infection was 6+ and in 89% of the cases a range of 4+ to 6+ was observed. No signs of ill-health were observed in the infected mice until near death. Postmortem examinations on all the intact mice showed enlargement of the spleen which in many cases was four to seven times the normal size. The liver was congested in 58% of the cases and kidneys in 25%. The liver of some mice showed scattered pin-point areas of hemorrhage. (BBB)

38822 EXPERIMENTAL ANIMAL STUDIES OF GERMINAL EPITHELIAL DAMAGE AFTER TELERADIOTHERAPY OF THE SKIN. Betetto, M. (Univ. of Ljubljana, Yugoslavia). Hautarzt, 19: 466-9(Oct. 1968). (In German).

Radiation effects on testis of guinea pigs were studied after administration of skin doses of from 2100 to 10,800 R of unfiltered soft or medium hard x irradiation. The doses were administered at a focal distance of 1 m, and at the rate of 150 R/day three times/week. The irradiation injuries produced in the testis were studied histologically. The irradiation injuries produced were not uniformly distributed in the testicular tissues. The reactions of the guinea pig testis that were observed were considered to be very similar to those in humans. The radiosensitivity of the germinal cells decreased in the order spermatogonia, spermatocytes, spermatids, and sperm cells. After irradiation the numbers of these types of cells decreased in a similar sequence. (BBB)

38823 BONE MARROW MEGAKARYOCYTE SYSTEM AND PLASMA THROMBOPOIETIC ACTIVITY IN X-RAY IRRADIATED MICE WITH AND WITHOUT PARTIAL SHIELDING. Krizsa, Ference; Rak, Kalman; Soevenyi, Ervin (Univ. Medical School, Szeged). Strahlentherapie, 137: 712-17(June 1969).

The serum of mice made thrombocytopenic by x-ray irradiation causes thrombocytosis along with an increase of the bone marrow megakaryocytes in recipient mice. In the protected femur of 300 R x-ray irradiated mice the giant cell content increases. When the lowering of the thrombocyte level is prevented by successive thrombocyte transfusions serum activity does not appear and the increase in the number of the megakaryocytes of the protected areas does not take place. By the introduction of thrombocytes even the megakaryocyte system of untreated mice can be suppressed. The giant cell content of the protected areas of x-ray-treated mice can be increased with active serum (received after irradiation) even in animals adjusted to normal platelet levels by means of thrombocyte transfusion. (auth)

38824 EFFECTS OF WHOLE-BODY IRRADIATION ON WEIGHT, PROTEIN CONTENT, AND ESTERASE ACTIVITY OF THE RAT LIVER. Valet, Guenter; Ruhenstroth-Bauer, Gerhard (Max-Planck-Institut fuer Biochemie, Munich). Strahlentherapie, 137: 734-41(June 1969). (In German).

After whole body x-irradiation of rats with 500 R, the weight of the liver, the protein content, and the esterase activity between pH 5.0 to 8.5 of liver extracts was followed from the first to the 18th day after irradiation. The results were tested to their statistical significance and they were correlated with the morphological appearance of the liver cells after the irradiation. So an insight was won concerning the modifications of the cell dimension, the cellular protein content and concentrations, and of the cellular esterase content and concentration. The dimension of the cell, the cellular protein content and concentration decrease after irradiation and the cellular content of esterase too, except at pH 5.0 which increases above normal level during a short time. The cellular concentration of esterase increases due to a high deperdition of non-esterase-active protein from the cell. The cellular protein concentration is the value who remains constant during the longest time, but needs the longest time for recovery. (auth)

38825 RADIOSENSITIVITY OF RODENT SPECIES. French, N. R. (Univ. of California, Los Angeles). Nature (London), 222: 1003-4(June 7, 1969).

It has been reported that wild species of rodents are more

resistant to acute radiation exposure than laboratory strains. The studies described, however, indicate that wild mice are quite sensitive to damage from chronic exposure in terms of life shortening and reduced fertility. The studies were conducted with laboratory-born descendants of wild deer mice (Peromyscus maniculatus), divided into a control group, an irradiated group, and a second irradiated group comprising the offspring of the original irradiated group. Irradiation was with ^{137}Cs γ radiation at 45 to 50 mR/hr, exposures averaging 1.23 R/day. Data on survival and natality were analysed to determine the effect of chronic low level radiation exposure on the intrinsic rate of natural population increase; this rate was 0.1897 in irradiated animals and 0.3134 in the controls. Irradiation reduced the average life span in both sexes, the shortening being highly significant. The reproductive life span of females was also shortened by irradiation. Survival in post-weaning age groups was, however, greater in irradiated animals, possibly due to radioinduced protection against infectious diseases. The data suggest that different species may differ considerably in sensitivity to chronic low level radiation exposure. (UK)

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Refer also to abstracts 38396, 38428, 38429, 38464, 38468, 38477, 38523, 38573, 38587, 38599, 38608, 38609, 38617, 38630, 38631, 38658–38660, 38717, 38726, 38728, 38729, 38739–38746, and 38792.

38826 (TT-68-50006/4) POLISH MEDICAL JOURNAL, VOL. 7, NO. 4, 1968. Translated for National Library of Medicine, Washington, D. C., from selected Polish medical publications. 254p. CFSTI.

Separate abstracts were prepared for four articles in this journal. The journal contains 29 additional articles on various aspects of diagnosis and treatment of disease. (H.L.W.)

For abstracts of individual papers see: 38694 and 38874–38876.

38827 PRETIBIAL MYXEDEMA THREE YEARS AFTER TREATMENT OF HYPERTHYROIDISM BY ^{131}I. Many, P.; Lapeyre, J.; Teillard, J.; Chabeau, G. Bull. Soc. Fr. Dermatol. Syphiligr., 73: 290-1(1968). (In French).

Development of pretibial myxedema as a sequel to radioiodine treatment in a 56-yr-old patient is reported. Because of rapidly progressive hyperthyroidism, the patient was given a single dose (9 mCi) of ^{131}I. Three yr later he presented severe pruritic lesions of the face and legs following a series of insect bites. They were superimposed on edema of these areas which resulted in urticaria. Topical treatment with antibiotic ointments improved the condition of the skin. Biopsy confirmed the presence of mucopolysaccharide in the lesions and the diagnosis of pretibial myxedema. Exophthalmos was present as well as other signs indicating a recurrence of hyperthyroidism. (BBB)

38828 LATE RESULTS FOLLOWING RADIOTHERAPY OF SKIN CANCER. Hansen, P. Bjerre; Jensen, M. Scharling (County and City Hospital, Odense, Denmark). Acta Radiol., Ther., Phys., Biol., 307-20(Aug. 1968).

Various methods of radiotherapy using radium treatment and x radiation therapy in 1,198 cases of histologically verified carcinomas of the skin are discussed. The results, particularly as regards the cure rate and cosmetic and functional sequelae, are considered in detail. (auth)

38829 SUPERVISION OF THE HIP JOINTS AFTER IRRADIATION OF FEMALE GENITAL CARCINOMA. Fries, Giselbert (Univ., Homburg, Ger.). Muenchen. Med. Wochenschr., 109: 1499-1503(July 14, 1967). (In German).

Osteoradionecrosis (ORN) of the hip region is found in 0.1–3.2% of the cases following roentgenradium therapy of female genital tumors. If treatment is started in time, the serious secondary changes of this damage (spontaneous solution and pseudo-arthrosis of the collum femoris) may be avoided. Since osteoradionecrosis generally is diagnosed and treated too late, it is suggested that the follow-up controls of the irradiated patients be extended to the hip region and that the patients themselves be informed of the possibility of bone lesions including their subjective and clinical symptoms to make them come in for adequate, orthopedic treatment as early as possible. (auth)

38830 MIXED MESODERMAL TUMOR OF THE UTERUS OCCURRING AFTER RADIOTHERAPY. Gudgeon, D. H. (Westminster Hospital, London). Proc. Roy. Soc. Med., 61: 1281 (Dec. 1968).

Possible development of a sarcoma in the uterus as a result of irradiation of an ovarian carcinoma is reported. In a 67-yr-old woman, bilateral ovarian serous cystadenocarcinomas were removed. There were multiple secondary deposits in the peritoneal cavity and the uterus was not removed. Postoperative radiotherapy gave a total dose of 4000 R to the pelvis and abdomen, and chlorambucil (5 mg daily) was administered. Her condition remained satisfactory until 18 months later when there was further vaginal bleeding. Curettings showed carcinomatous and sarcomatous tissues. Hysterectomy was carried out; at operation there was no evidence of malignant disease in the peritoneal cavity. The uterine tumor was confirmed as a mixed mesodermal tumor. She developed an iliofemoral vein thrombosis, and died 5 months later. Previous reports indicate that there is a definite relation between previous irradiation and mixed mesodermal tumors. The time interval between irradiation and tumor development was two to 16 yr. (BBB)

38831 RADIATION EFFECTS ON THE HUMAN CENTRAL NERVOUS SYSTEM 14 WEEKS AFTER X RADIATION. Monro, Pauline; Mair, W. G. P. (National Hospital, London). Acta Neuropathol., 11: 267-74(Nov. 1, 1968).

A case is reported in which neurological symptoms developed eight weeks after x irradiation of a pituitary adenoma. Postmortem examination 14 weeks after irradiation showed changes of central nervous system tissues in the path of the beam similar to those seen in two other cases reported with a similar latent period, and to that produced in experimental animals. The changes consisted of demyelination, loss of oligodendroglia, presence of abnormal giant astrocytes, and increased vascularity with no obvious change in the vessel walls. The histological changes and the latent period were probably accounted for by a direct effect of radiation on the oligodendroglia and on the replicating mechanism of sensitive cells, particularly the astrocytes. The more commonly reported instances of changes, seen after a much longer latent period and developing more slowly, could be produced in the same way. Vessel changes were pronounced in these late cases, but they were not the only cause of the necrosis and were not necessarily indicative of a different reaction to irradiation. (BBB)

38832 DEEP TRICHOPHYTOSIS AFTER X IRRADIATION. A CONTRIBUTION TO THE PATHOGENESIS OF DERMATOMYCOSES. Schirren, J. M. (Albrechts-Univ., Kiel). Hautarzt, 19: 363-5(Aug. 1968). (In German).

A case is reported of dermatomycosis produced in a slaughterhouse worker by infection with wild yeast during treatment with daily fractionated x irradiation doses of 100 R for Schmincke tumor metastases of the cervical lymph nodes. Until the irradiation treatments the patient had worked daily for years with infected cattle without suffering from dermatomycoses. Irritation of the skin by x rays facilitated development of severe trichophytosis of the area irradiated. Reports of Trichophyton mentagrophytes infections in skin areas of guinea pigs 8 days after irradiation with 3000 R of x ray are discussed. These were similar to infections of Trichophyton gypseum produced in skin of patients who received a combination of x irradiation and inoculation by rubbing. Mycoses apparently developed primarily at the site of greatest trauma or injury. (BBB)

38833 LEUKEMIA FOLLOWING RADIOIODINE TREATMENT OF THYROTOXICOSIS. Brownlie, B. E. W. (Princess Margaret Hospital, Christchurch, N. Z.). N. Z. Med. J., 67: 621-2(June 1968).

The first reported New Zealand case of leukemia following ^{131}I therapy for thyrotoxicosis is presented. The patient, a 64-year-old man, received 15 mCi of ^{131}I for thyrotoxicosis at the age of 51 yr in October, 1953. There was an initial response but a further 12 mCi was required in October, 1954. A few months later the patient became clinically myxedematous and since that ime has been on replacement thyroxine therapy. In October, 1966, he was diagnosed as having leukemia. The time lapse of 13 yr between the administration of the ^{131}I and the development of leukemia is longer than in most of the reported cases (one or two yr). The time interval was also much longer than that reported between external radiation for ankylosing spondylitis and the development of of leukemia (five yr). The type of leukemia (chronic myeloid) is also different from the majority of cases following ^{131}I where there is a preponderance of acute leukemia cases. For these reasons, the relation between ^{131}I and the development of leukemia in this case is not definite. (BBB)

38834 TELEGAMMA THERAPY WITH SINGLE HIGH DOSES. Bohndorf, Werner (Univ., Wuerzburg, Ger.). Roentgen Bl., 21: 65-8(Feb. 1968). (In German).

Irradiation effects produced during treatment of tumors with ^{60}Co or ^{137}Cs at various dose levels are discussed. Increasing the weekly dose from six doses of 200 R to five of 300 R for treatment of laryngeal carcinoma did not increase skin or mucosal irradiation reactions. Three weekly doses of 500 R each produced severe exudative changes and increased mucous formation.

Similar results were produced after treatment of the lymphatic drainage areas of the jaw and supraclavicular fossa, and the patients' general condition worsened. Persistent edemas were observed. In adenocarcinomas of the nose where total doses of 8000 R at a rate of three of 500 each were given weekly, no skin reactions were observed if enough separate fields or pendulum irradiation was used. Radiopneumonitis was more frequent and severe after treatment of parvicellular carcinoma with three doses of 500 R each totaling 4500 R, followed by a second series four to six weeks later totaling 2500 R than after similar treatment of bronchial carcinoma. In other studies no disadvantages resulted when 1000 R was given weekly. High single doses for treatment of bladder carcinoma produced cystitis and severe tenesmus. (BBB)

38835 MANAGEMENT OF RECURRENT CARCINOMA OF THE CERVIX. Keettel, William C.; Van Voorhis, Lee W.; Latourette, Howard B. (Univ. of Iowa, Iowa City). Amer. J. Obstet. Gynecol., 102: 671-9(Nov. 1, 1968).

Complications and clinical results of radiotherapy were assessed in 145 patients with recurrent carcinoma of the cervix. External irradiation, usually with ^{60}Co and Ra or ^{198}Au local irradiation, was used. In one group of patients re-treated with radiation there was one vesicovaginal fistula due to tumor recurrence, five instances of radiation cystitis, five of radiation proctitis, and one lower extremity motor nerve injury following ^{198}Au irradiation. In the second group of patients there were more irradiation complications resulting in one vesicovaginal fistula, one severe skin reaction, one fracture of the hip, four proctitis, and three irradiation cystitis. There were four bowel strictures; one resulted in a small bowel fistula with generalized peritonitis and death. In the patients treated by reirradiation, there were four patients who survived 5 yr (3.1%). Satisfactory palliation was achieved in 54% of the patients without an excessive number of serious complications. (BBB)

38836 COMPLICATIONS OF RADIOTHERAPY OF CANCER OF THE UTERINE CERVIX IN STAGE III. Pourquier, H. J. Radiol., Electrol., Med. Nucl., 49: 607-16(Aug.-Sept. 1968). (In French).

Complications resulting from the radiation exposure of adjacent tissues during γ radiotherapy of carcinomas of the uterine cervix are discussed. Injuries to the intestine, blood vessels, and bones following radiotherapy are described and the possible causes of these complications are discussed. (85 references) (C. H.)

38837 BREAST CANCER: RADIATION EFFECTS ON THE MYOCARDIUM. Cooper, Elmer E. Tex. Med., 63: 52-9(Dec. 1967).

In 30 patients under 50 yr of age, postoperative megavoltage γ radiation to the left chest for breast cancer produced electrocardiographic (ECG) changes. Patients with right breast radiation therapy showed no ECG changes during or after therapy and served as controls. In each instance of irradiation to the left chest, however, ECG abnormalities occurred during therapy and worsened for six months after completion of treatment. It was concluded that when the megavoltage therapy is offered postoperatively as prophylactic treatment for left breast cancer, the likelihood of occult disease being effectively treated must be weighed against the possibility of myocardial injury. (BBB)

38838 HEMORRHAGIC RADIATION CYSTITIS. Goldstein, Arthur G.; d'Escrivan, Julio C.; Allen, Samuel D. (Burlington County Memorial Hospital, Mt. Holly, N. J.). Brit. J. Urol., 40: 475-8(Aug. 1968).

A rational scheme of management for gross or microscopic hematuria following irradiation therapy to the pelvis is presented. Recent experiences in treating four patients and a literature review are discussed. Radiation cystitis may occur at any time from months to 14 yr after completion of irradiation therapy. The mucosa atrophies, becomes thin, pale, and inelastic, while marked fibrosis and capillary dilatation occur in the submucosa. Necrotizing arteriolitis results in impaired contractility of the vessels as the musculature of the arterioles is replaced by fibrous tissue. The altered bladder vasculature is fragile and can be the source of recurrent profuse hemorrhage. Radiation-induced bladder injuries occur more often in patients with underlying bladder disease when higher doses of irradiation are given. Hematuria most frequently follows intracavitary irradiation therapy, and is unusual after supervoltage therapy. If a specific lesion exists, biopsy will distinguish recurrent neoplasm from radiation reaction. Initial conservative treatment consists of adequate blood replacement, prednisone, tocopherol, constant bladder irrigations with $AgNO_3$ if frequent clot retention occurs or previously employed drugs are unsuccessful, fulguration in cases where a specific bleeding point is noted, appropriate chemotherapy, and direct electric current hemostasis. Should conservative therapy fail, supravesical diversion, bilateral hypogastric artery ligation, or cystectomy are indicated. (BBB)

38839 TREATMENT OF INOPERABLE CARCINOMA OF THE BRONCHUS BY MEGAVOLTAGE X RAYS. Deeley, Thomas J.; Singh, S. Padam (Hammersmith Hospital, London). Thorax, 22: 562-6(Nov. 1967).

The immediate reactions and the late complications of treatment of carcinoma of the bronchus using 8 MeV x rays are described. The reactions were no more severe than with orthovoltage x-ray therapy. The reactions that occurred within a few weeks of irradiation were caused by the direct effects of radiation on either the esophagus or the normal lung tissue. Irradiation irritated the esophageal mucosa, with the formation of a mucous membrane reaction similar to that found on the mucosa of the mouth and throat. Of patients that received radical radiotherapy for a carcinoma of the bronchus 56% complained of some degree of dysphagia, usually occurring about the third week of the treatment. In only 2% of patients was the dysphagia severe enough to necessitate stopping the treatment. When dysphagia developed the treatment was stopped for a few days until the symptoms subside, and then the patient was often able to continue to the full planned dose. Irradiation caused increased size and density of the opacity in the treated lung, and evidence of lung fibrosis and shrinkage. In the initial stage of reaction the opacity was hazy in appearance, but also showed patchy areas of consolidation which may coalesce to form dense shadows. Histological section showed reaction in the lung parenchyma, filling of the alveolar spaces with macrophages and exudate, and thickening of the alveolar walls with lymphocytic infiltration of the interstitial tissues. These changes were followed by fibrosis and shrinkage. In all patients there was lung shrinkage at about 12 months, with fibrosis and complete loss of tissue structure. The fibrosed lung was very prone to infection. (BBB)

38840 RADIATION TREATMENTS OF MAMMARY CARCINOMA. Stender, H. St.; Kimitsch, B. (Medizinische Hochschule, Hanover). Chirurg, 39: 263-70(June 1968). (In German).

Complications that may appear after irradiation for mammary carcinoma are described. Skin irritation by heat, cold, pressure, friction, or irritant liquids must be avoided. A neutral powder should be applied several times daily during the irradiation period and for three months afterward. For erythema or epithelitis with epitheliolysis, salves and warm physiological saline or chamomile compresses can be used. Infections are treated with antibiotics and cortisone sprays before bandaging. Severe necroses are rarely observed. Atrophic skin changes with teleangiectases appear as late irradiation effects. Lung reactions to irradiation appear in 10 to 66% of cases, with costal, mediastinal, or diaphramal thickening and distortion. With tangential fields small, anterior peripheral lung zones and the tips may receive over 4000 R. Usually pneumonitis appears from three to six months after irradiation is started. Symptomatic treatment of cough and antibiotics for infections are required. Breathing exercises should be started during irradiation to improve function and retain elasticity. Osteonecroses of irradiated ribs may be observed but 90% heal spontaneously. Osteoporosis of the ribs may occur. Edema of the arm appears in 13 to 57% of cases even with precautions. The number of arm edemas increases after irradiation and lymph node removal, and decreases if the minor pectoral muscle is not resected. (BBB)

38841 VITILIGO AFTER X IRRADIATION OF MULTIPLE MELANOMA METASTASES. Roth, W. G. (Hautklinik, Nuernberg). Hautarzt, 19: 178-80(Apr. 1968). (In German).

A case of facial vitiligo that appeared after irradiation of melanoma metastases located on the leg with a total of ~200000 R of x irradiation given over 5 yr is reported and discussed. Vitiligo foci that appear after radiogenic destruction of melanoma cells independently of the irradiated melanoma are believed to result from an antigen-antibody reaction. (BBB)

38842 EFFECTS OF THORACIC RADIATION ON PULMONARY FUNCTION. Yasuda, Ryuzaburo (Kyoto Univ.). Bull. Chest Dis. Res. Inst., Kyoto Univ., 1: 43; 138-70(Mar. 1968). (In Japanese).

Radiotherapy with ^{60}Co γ has advanced and been carried out more extensively in patients with lung cancer, who have increased in Japan as well as in Europe and the U.S.A. It is necessary to understand the pulmonary function of the patients who have lung cancer and the effects of thoracic radiation in order to make a functional prognosis of the cases or to decide on the indication for surgical treatment. In this study, pulmonary diffusing capacity including D_M and Vc, lung volume, ventilatory function, and intrapulmonary gas distribution were measured in patients with lung cancer, and in patients who had radiation therapy to the chest. The measurements were done periodically, and as late as possible

after irradiation. The result revealed that the diffusing capacity of lungs with cancer was lower than normal, probably caused by the senile emphysema accompanying lung cancer, and that only the diffusing capacity was affected to a great extent by irradiation of the chest. On the other hand, the pulmonary diffusing capacity was also measured in experiments before and after irradiation by ^{60}Co γ to the chest of dogs. The lung tissues of the dogs that had died of radiation pneumonitis or had been killed, were extirpated for histologocal examination. It was found that the changes of the pulmonary diffusing capacity might be attributed to the alterations in the thickness and permeability of the alveolar membrane and the decrease in the capillary bed. (NSA of Japan)

38843 PROGRESSIVE MYELOPATHY DUE TO RADIATION. Coy, P.; Baker, S.; Dolman, C. L. Can. Med. Ass. J., 100: 1129-33(June 28, 1969).

Three cases of progressive myelopathy following irradiation of the thoracic spinal cord in the treatment of malignant disease of the lung were reported. The clinical features, pathology and radiotherapy, were described and discussed. It was suggested that with a cord dosage in the region of 4000 rads given in three to four weeks, some patients may be expected to develop progressive myelopathy. It is further suggested that this risk is not justified if the increased tumor dose is not accompanied by an improved survival, and that for practical purposes a spinal cord dose of 3750 rads in three to four weeks should not be exceeded. (auth) (Canada)

38844 DELAYED RADIONECROSIS SIMILAR TO A LARGE MASS IN ONE HEMISPHERE AFTER RADIOTHERAPY FOR A PITUITARY TUMOR: CASE REPORT. Sasabe, Tetsuya Leslie (Osaka National Hospital). Med. J. Osaka Univ., 19: 71-9(Sept. 1968).

Occurrence of cerebral radionecrosis in a 63-yr-old woman is reported. The patient was treated for pituitary tumor with ^{60}Co teletherapy through right and left lateral opposing 6 × 6 cm fields, with the target-skin distance of 75 cm. The total dose was 7500 R. The patient had experienced a left hemiparesis, and dysarthria. Two yr later, examination revealed a left homonymous hemianopsia, bilateral optic atrophy, a left central facial palsy, protrusion of the tongue to the left, and a left flaccid hemiparesis. On sensory examination there were astereognosis, agraphesthesia, disturbed spatial discrimination in the left upper and lower extremities. One was weakness in the right arm, and no Babinski's sign was elicited in both legs. The spinal fluid pressure was 140 mm of water and a protein of 61 mg %. On suspicion of a mass in the right cerebral hemisphere from x-ray evidence, a right osteoplastic craniotomy was performed. When the dura was opened, the temporal, parietal, and occipital lobes showed widened gyri, discoloration, and relatively soft areas. Sections from these areas disclosed necrotic tissues. An internal decompression was carried out by removing all visible abnormal tissues. The patient died of acute pneumonia on the 2nd day after surgery. Autopsy disclosed that the pituitary gland had lost its original form and become necrotic. Necroses were found in the white matter of the right precentral, parietal, temporal, and occipital lobes, and in the ventrolateral aspect of the upper pons. No such changes were demonstrated in the left hemisphere. Microscopic examination showed cerebral arterial vessel lesions. In vessel walls there were endothelial proliferation, hyaline degeneration, and hyperplasia of collagen. Axis cylinders were fragmented or completely destroyed; a transitional zone between necrotic and relatively normal areas was seen. (BBB)

38845 CARCINOMA OF THE CERVIX: FIVE-YEAR RESULTS AND SEQUELAE OF TREATMENT. Muirhead, W.; Green, L. S. (Hamilton Clinic, Ont.). Amer. J. Obstet. Gynecol., 101: 744-9 (July 15, 1968).

Occurrence of radioinduced complications and their treatment in 586 patients irradiated for cervical cancer are reported. An applicator was inserted on two occasions at a 7-day interval to produce a Ra dose of 7000 R at Point A, 2 cm lateral to the internal os. In addition, ^{60}Co γ radiation to a tumor dose of 4000 R centrally was given in 4 weeks by parallel opposed 17 × 10 cm fields with a 4-cm wide central lead block. Nineteen cases in the series (3.2%) required surgical intervention for treatment sequelae. Seven of these cases were relieved by such operations as small bowel resection or transplantation of the ureter into the dome of the bladder. Twelve other patients had a permanent disability, such as colostomy, fistula, or contracted bladder, as a result of treatment. Three cases of bowel injury were due to Ra overloading the lower end of the short intrauterine stem in cases with a short uterus or cases of stump carcinoma. The fourth case required a colostomy for a sigmoid colon reaction in relation to the tip of the uterine stem. Sporadic hematuria occurred in 3% from the third year onward, but required no treatment. There was one case of vesico-vaginal fistula and 12 cases of hydronephrosis. There appears to be no method of predicting hydronephrosis since probe dosimeter bladder readings also do not correlate well with the development of hydronephrosis. All the cases of hydronephrosis were detected of 3 to 5 yr after treatment. Avoidance of constipation and maintenance of electrolyte balance are most important during radiation treatment of carcinoma of the cervix. (BBB)

38846 EXPERIMENTAL STUDIES ON THE ETIOLOGY OF LATE UROLOGIC COMPLICATIONS AND THEIR THERAPEUTIC CONSEQUENCES. Fischer, W. (Univ., Berlin). Zentralbl. Chir., 92: Suppl., 2026-31(1967). (In German).

Effects of irradiation on development of urological complications were studied. As long as only the mucosal tissue was injured by irradiation the inflammatory reaction was reversible, but if the bladder wall became scarred, there was irreversible loss of elasticity. The mucosal injuries observed in the first weeks or months after irradiation, which were not accompanied by any change in the cystogram, had the most favorable prognosis. The later and the more persistently that the bladder was partially or entirely atonic, with diverticulated sides or a conically shaped fundus, the more vesicoureteral reflux was likely to occur and the prognosis was worsened. Urinary obstruction was associated with a rigid, piniform shrunken bladder with the ureters entering at a right angle. Ureteral peristalsis was easier to normalize after combined Ra and x-irradiation therapy than after surgical operation. There was less likelihood of extremely severe inflammations of the bladder during the postirradiation period if the urinary tract was free of infection. (BBB)

38847 PRENATAL BONE INJURIES CAUSED BY IONIZING RADIATION. Szanto, D. (Radium Inst., Miskolc, Hungary). Fortschr. Geb. Roentgenstr. Nuklearmed., 110: 886-9(June 1969). (In German).

The simultaneous occurrence of myeloid leukemia and dysplasia osteochondrotica in a seven-year-old child is described. It is assumed that pre-natal damage of the maternal gonads from radiodiagnostic investigations is responsible. (auth)

38848 RESULTS AND COMPLICATIONS OF TELECOBALT THERAPY IN BRONCHIAL CARCINOMAS. Fernholz, Hans-Joachim; Mueller, Gerd (Technische Hochschule, Aachen). Strahlentherapie, 137: 381-92(Apr. 1969). (In German).

The results of telecobalt therapy in 124 patients with bronchial carcinoma from 1964 through 1967 are discussed. The mean survival was 9.3 months. In a high number of cases complications occurred during and after therapy. Because of their influence on survival time, these complications are analyzed and it is suggested that indication for radiotherapy in bronchial carcinomas be approached cautiously. (H.B.G.)

38849 TO WHAT DEGREE IS EXPOSURE TO X-IRRADIATION RESPONSIBLE FOR THE CAUSATION OF MALIGNANT DISEASES IN CHILDHOOD? PART II. DISTURBANCES OF OSSIFICATION IN THE HAND BONES OF LEUKEMIC CHILDREN. Gefferth, Karl (Univ. of Budapest). Strahlentherapie, 137: 442-50(Apr. 1969). (In German).

In order to verify the ancient hypothesis that leukemic children are constitutionally abnormal, bone ossification was examined. Radiographs of the hand were studied by four methods. The results showed clearly that there was significant delay when compared to international standards but also compared to children with other diseases. The conclusion is that leukemic children have an inferior anomalous constitution already before the clinical manifestations and that the osseous condition is not caused by the leukemia. These patients are in a labile condition due to an unknown anomaly. This explains that low doses of radiation delivered by radiologic pelvimetry could cause a malignant disease. (auth)

38850 DIMINISHED FUNCTIONAL PARATHYROID RESERVE FOLLOWING ^{131}I TREATMENT FOR HYPERTHYROIDISM. Better, O. S.; Garty, J.; Brautbar, N.; Barzilai, D. (Rambam Government Hospital, Haifa, Israel). Israel J. Med. Sci., 5: 419-22 (May-June 1969).

A study was conducted in volunteers (physicians and medical students) to devise a test to assess parathyroid reserve that would be safe, well tolerated, and easily performed. With the aid of this test, a population of patients receiving ^{131}I treatment for hyperthyroidism was surveyed to determine the incidence of diminished parathyroid functional reserve (DPFR). Correlations were made between the incidence of DPFR, the dose of ^{131}I received, and the length of time elapsed since therapy. (E.R.B.)

38851 CHANGES IN THE ANKLE JERK TIME IN THE COURSE OF RADIOTHYROIDECTOMY AND THE TREATMENT OF SUBSEQUENT HYPOTHYROIDISM. Vana, Stanislav; Zam-

razil, Vaclav; Nemec, Jan (Research Inst. of Endocrinology, Prague). Rev. Fr. Etud. Clin. Biol., 14: 380-3(Apr. 1969).

Following the administration of a dose of ^{131}I that suppresses thyroid function, there is a slow increase in the ankle jerk reflex time. It was only 2 months after treatment that changes in the reflex times, in successfully treated patients, could be detected. The prolongation of the reflex time continues until the third month. A failure to obtain an increased reflex time during the first two months after treatment can not be taken as an indication that total destruction of the thyroid had not occurred. During therapy of induced hypothyroidism by thyroid extracts or triiodothyronine, the shortening of the reflex time was rapid. Significant changes can be recognized within 4 days and the majority of the patients were in normal limits within 3 weeks, which corresponds with the time to saturate the skeletal muscle with thyroid hormones. (auth)

38852 ENDOSTEAL SENSITIVITY TO TUMOR INDUCTION BY RADIATION IN DIFFERENT SPECIES: A PARTIAL ANSWER TO AN UNSOLVED QUESTION? Mole, R. H. (Medical Research Council, Harwell, Eng.). pp 249-61 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

The quantitative evidence from animal experiments with α- and β-emitting bone-seeking nuclides and from human experience with radium suggests that the radiosensitivity to tumor induction of the whole endosteum is the same in all species. This generalization could be tested in man by observation for bone tumors in cases of polycythemia treated with ^{32}P. For ^{90}Sr the probability of bone tumor induction appears to be directly proportional to the square of the number of β-particles liberated in the skeleton per kilogram of body-weight in both dog and mouse and the constant of proportionality is very nearly the same. The form of the dose-response relationship for α-emitters needs to be clarified. (auth)

38853 ^{224}Ra-INDUCED TUMORS IN CHILDREN AND ADULTS. Spiess, Heinz (Univ. Childrens Clinic, Goettingen, Ger.). pp 227-47 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

In the years 1944 to 1951, about 2000 patients were treated in German hospitals for tuberculosis and other diseases with a preparation containing ^{224}Ra (Th-X). They had received total amounts of 40 to 5000 μCi of ^{224}Ra in repeated injections, each of 8 to 70 μCi. ^{224}Ra concentrates in growing bone. Repeated injections led to serious damage to the epiphyseal cartilage, irregular ossification, broadening of the primary spongiosa, and the formation of growth-arrest plates. The younger the age at injection, the more severe the skeletal damage. Bone sarcomas appeared in 50 patients, 35 injected before 21 yr of age. Already 17% of the 206 injected youths have developed sarcomas of bone. Radiation-induced growth retardation occurred in 42% of the 99 injected youths whose adult heights could be measured. Benign osteochondromas were identified in 36% of 50 injected youths examined radiographically. The ^{224}Ra decay product ^{212}Pb is bound to erythrocytes and can be found especially in organs well supplied with blood, such as the liver. The decay product ^{212}Bi concentrates in the kidneys. Liver disease was the cause of death in 11 patients, and 14 others died of kidney disease. (auth)

38854 RADIOGENIC TUMORS IN THE RADIUM AND MESOTHORIUM CASES STUDIED AT MIT. Evans, Robley D.; Keane, A. T.; Kolenkow, R. J.; Neal, W. R.; Shanahan, M. M. (Massachusetts Inst. of Tech., Cambridge). pp 157-94 of Delayed Effects of Bone-Seeking Radionuclides. Mays, Charles W. (ed.). Salt Lake City, University of Utah Press, 1969.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho. See CONF-670938.

Some generalizations are drawn from our study of 496 persons having skeletal burdens of radium (^{226}Ra) or its 5.7 year half-period isotope, mesothorium (^{228}Ra). The duration of their exposure was usually less than 1 yr, but extends to as long as 20 yr. Their burden time was most commonly 40 to 50 yr, but covered a range of 4 to 65 yr. Dosimetry was performed at three levels: gross dosimetry (whole-body parameters such as measured terminal burden, estimated initial burden, or cumulative rads of skeletal average dose); macro-dosimetry (measurements on individual bones or bone groups); and microdosimetry (measurement of dose-rate and estimation of cumulative dose to small regions of specific target tissues). Measurements of the radon concentration in the sinus and mastoid air spaces showed that radon and its daughter products contributed a significant portion of the total α-ray dose to the sinus and mastoid epithelium. In one person who developed a carcinoma in the frontal sinus, the cumulative dose to the region of the nuclei of basal cells in the sinus epithelium exceeded 82,000 rads (mostly from the underlying bone), while the skeletal average dose was only 3000 rad. Dose-vs-response relations were studied for a wide variety of parameters. When the cumulative skeletal dose in rads decreased, the tumor appearance time for the sarcomas and carcinomas associated with skeletal deposits of Ra or MsTh appeared to increase. This led to the identification of a practical threshold of dosage, below which the required tumor appearance time generally exceeded the life-span, and hence radiation-induced tumors appeared with negligible frequency. A 10 yr retrospective study showed that each of the six individuals who developed a radiogenic tumor between 1957 and 1967 had received an average skeletal dose that exceeded some doses that had produced tumors at shorter appearance times. The fraction of persons with malignant tumors arising from skeletal Ra and MsTh was roughly the same in the series for all dosage levels from 1200 to 50,000 rads skeletal average dose, and so far is zero below 1200 rads. When all measured cases were included, the tumor incidence above 1200 rads was about 40%. When cases that came to our attention because of a diagnosis of their symptoms were excluded, the remaining statistically suitable population had a tumor incidence of about 30%. If a sigmoidal region joins the low-dosage and the 1200 rad domains, its slope must be quite steep. The measured incidence data are clearly in violent disagreement with a linear nonthreshold dose-vs-response hypothesis — the probability that statistical fluctuations could give rise to differences as large or larger than those observed being less than 1 in 100,000. (auth)

38855 LATE EFFECTS: EXTRAPOLATION TO LOW DOSE RATE EXPOSURES. Storer, John B. (Atomic Energy Commission, Washington, D. C.). Health Phys., 17: 3-9(July 1969).

The sources of information on late radiation effects in man are reviewed and the findings to date discussed. The uncertainties in extrapolation of the data to low doses and low dose rate are considered in detail, and the biological basis for various methods of extrapolation are discussed. A range of estimates of the magnitude of effects to be anticipated from low dose exposures to human populations is given. (auth) (UK)

38856 LASER IN PEDIATRIC SURGERY. Henderson, Bruce M.; Goldman, Leon; Martin, Lester W.; Rockwell, R. James (Univ. of Cincinnati). J. Pediat. Surg., 3: 263-70(Apr. 1968).

Effects of laser irradiation in animal (rat, hamster, dog) and clinical studies are reported. Skin incisions made by a low-energy Ar laser (1 to 4 w) required several minutes and resulted in considerable charring of skin, producing prominent scars in dogs. Pigmented skin was incised more readily than white. This was true of deep structures also. For instance, the relatively clear fascia was divided with difficulty, but muscle being darker was incised more easily. Bleeding did not occur while incising tissue with the Ar laser. Microscopic examination of ruby laser impact sites in skin initially showed disruption of epidermis with coagulation necrosis. Vesiculation occurred in the adjacent areas. Darker skin color seemed to accentuate this process. The collagen of the upper third of the corium was coagulated and elastic fibers became short and curled. Endothelial cells of nearby vessels were swollen; and hemolysis with coagulation of red blood cells was seen in the capillaries. Hair follicles and sweat glands were relatively resistant and frequently appeared normal. A few days later, epithelial regeneration was found around these hair follicles. Healing then progressed with formation of local superficial scarring and epithelialization. There was a considerable reduction of capillaries in the area and those present were compressed by dense collagen. Following ruby laser impacts in the brain, well-localized lesions were produced with irreversible neural damage that was followed by delayed astrocytosis. Ruby laser impacts on the intact skull produced cerebral edema and subdural and subarachnoid hemorrhage in rats. Use of ruby laser irradiation to treat port-wine hemangioma in children is also described. Of the 43 cases treated, 22 showed definite fading without excessive scarring at the impact sites. (BBB)

38857 COMPLICATIONS ASSOCIATED WITH COMBINED AND IRRADIATION THERAPY OF CERVICAL CANCER. Timonen, Sakari (Univ. Central Hospital, Helsinki). Ann. Chir. Gynaecol. Fenn., 56: 361-6(1967).

Among 150 patients with cervical cancer, 50 patients were treated by combined surgery and radiotherapy, and 100 patients with irradiation alone. The two series were of similar age structure, and the clinical stage and year of treatment was the same. The treatment consisted of radical surgery with lymphadenectomy combined with one preoperative Ra γ application and postoperative ^{60}Co γ or x-ray therapy. Early metastases were more common in the irradiated patients. Transient hydroureter and hydronephrosis were much more common in the operated group of patients. The

difference leveled off after one yr. The frequency of transient and permanent lesions of the urinary tract was higher in the patients who had urinary tract infection before treatment. Other complications, especially the intestinal irritation syndrome and intestinal lesions, were more common in the irradiated than in the operated patients. Possible ways to avoid radioinduced lesions of the urinary tract are discussed. (BBB)

38858 INFLUENCE OF CONTINUED SMOKING ON THE INCIDENCE OF SECOND PRIMARY CANCERS INVOLVING MOUTH, PHARYNX, AND LARYNX. **Castigliano, S. Gordon (American Oncologic Hospital, Philadelphia). J. Amer. Dent. Ass., 77: 580-5 (Sept. 1968).**

Effects of smoking on occurrence of second primary cancers of the nicotine-sensitive region in patients previously treated with radiotherapy are discussed. In one study of patients treated by irradiation, a second primary cancer developed less frequently in the patients who continued to smoke when compared with the patients who stopped smoking, in whom second cancers rarely developed. In a second study, 27 patients were treated by irradiation alone, 29 were treated by both irradiation and surgery, and 29 by surgery alone. Of the patients in whom a second cancer developed, 68% were treated by irradiation. Of the patients in whom a second cancer did not develop, 68% were treated by use of irradiation. The method of treatment and the incidence of a second primary lesion were compared. It was concluded that short period of followup does not allow the carcinogenic effects of irradiation to be felt completely. The average delay period of cancers caused by irradiation therapy was more than nine, and may average 23 yr. The total dose of irradiation was a factor. Smoking of any kind was not recommended for patients following radiotherapy of cancer in the nicotine-critical tissues, such as mouth, larynx, and pharynx. (BBB)

38859 ANGIOGRAPHIC ASPECTS AFTER IRRADIATION OF THE PELVIC REGION. **Rossi, L.; Gagnoni Schippisi, G.; Accinelli, G.; Merialdi, A. (Univ., Parma, Italy). Ateneo Parmense, Sez. 1, Numero Speciale, 363-88 (1967). (In Italian).**

Speculative and practical aspects of following radioinduced changes in irradiated tissues by arteriography are considered, and are illustrated by reference to women subjected to radiotherapy for uterine cervical carcinoma. The patients, aged 36 to 70 yr, had received telecobalt or x-ray treatments after Ra implantations. Telecobalt irradiation consisted of a focal dose of 4000 R fractionated over 25 days. Fifty days to 5 yr later, transfemoral retrograde arteriography was used to study changes in the irradiated tissues. During treatment, the x-ray films showed the rich vascularization of tumor tissue, whereas at the end of radiotherapy reduced vascularity, with rigid, contorted vessels, was seen. At 3 months postirradiation, vessels were scarce in tumor tissue, and the vessels present were injected slowly and with difficulty by the contrast agent. Persistence of viable tumor tissue could be visualized on the angiograms. Correlation of these pictures with histopathologic findings is considered, particularly the early inflammatory changes and the late sclerotic reaction. Clinical significance of arteriography is discussed. The persistence of the preirradiation type of tumor vascularization 3 months after irradiation usually indicates failure of radiotherapy to eradicate the tumor. (BBB)

38860 BIOLOGIC EFFECTS OF NONIONIZING ELECTROMAGNETIC RADIATIONS. **Richardson, A. W. (Southern Illinois Univ., Carbondale). Scientia (Milan), 103: 447-53 (Sept.-Oct. 1968).**

Effects of radar and other microwaves on the living organism and the potential hazard to humans are discussed. Microwaves range from 0.1 to 300 cm, and include radar, long-distance telephone signals, and TV signal relays. The bands important for physiological hazards are between 1 and 300 cm, with 100 to 30,000 MHz frequencies. The half-loss penetration of 2450 MHz microwaves in tissues is about 8.4 mm depth. Excessive acute exposure to high field density is lethal to the rat and rabbit within nine to 10 min and is followed by cardiac failure. Young rats exposed sublethally eight to 13 times using 12.25-m microwaves of less than 90 mw/cm^2 have a 20 to 50% shorter life span than normal control rats, after exposure periods of 10 to 15 min, and a day to a week between exposures. Pulsed microwave radar of 12.25 m produces lenticular opacity at the posterior segment of the lens; 8-cm microwaves produce lenticular opacity in the anterior segment of the lens, and 3-cm waves produce corneal opacity. With excessive exposures just above threshold, the opacities are formed from two days to six months after exposure. Ocular glutathione is depleted by the exposures. Lenticular opacities are more readily formed with less energy in rabbits that have diabetes mellitus. Microwaves and irradiation both destroy sperm in the testes. Microwave exposures of less than 80 mw/cm^2 field strength reverse the action of ouabain and digitoxin in rats. A field of 10 mw/cm^2 is permissible for very short human exposures and 1 mw/cm^2 is permissible for exposure up to eight hr. (BBB)

38861 THE PROBLEM OF INJURIES AFTER X-RAY DIAGNOSTIC STUDIES. **Hermann, H.; Kroker, K.; Nawrath, H.; Wieser, O. (Univ., Heidelberg). Beitr. Klin. Erforsch. Tuberk., 13: 148-50 (1969). (In German).**

A group of 270 patients with pulmonary diseases were given total doses of either 21 R in 50 fluoroscopies over a period of 2 yr, or 914 R in 150 fluoroscopies. No leukemias were observed after the irradiations, during follow-up studies of up to 6 yr. This interval was probably too short for leukemia to develop. It was reported that the leukemia rate was doubled by a bone marrow dose of 94 R during follow-up periods of 5 to 10 yr. It was concluded that although there was some possibility of development of leukemia or tumors after x irradiation, these types of irradiation injuries did not consistently appear in all patient groups. (BBB)

38862 JEOPARDIZATION OF THE EYEBALL BY MODERN RADIOTHERAPY OF TUMORS IN THE VICINITY OF THE EYE. **Kleberger, K.-E.; Gerstenberg, E.; Krokowski, E. (Freie Univ., Berlin). Klin. Monatsbl. Augenheilk., 154: 401-10 (Mar. 1969). (In German).**

Irradiation injuries of the eye following radiotherapy with ^{60}Co of carcinomas of the paranasal sinuses were reported. Simultaneous irradiation of the eye was unavoidable in 57 out of 117 cases. It was observed that if the eye was irradiated with doses of ^{60}Co γ rays greater than 4000 R, severe irreversible ocular lesions could be expected up to the end of 2 yr of survival after irradiation. These injuries were in addition to the reversible or slight reactions to irradiation and cataracts that developed. The severe irradiation injuries observed included corneal opacities with vascularization and ulceration up to the stage of perforation, iritis with hyphema, and secondary, very painful glaucoma. These lesions were seen in four out of ten patients who survived for long periods. Another case was observed after irradiation of a malignant lid tumor which had penetrated into the orbit. (BBB)

38863 ELECTRON MICROSCOPICAL AND X-RAY CRYSTALLOGRAPHIC INVESTIGATIONS OF TEETH EXPOSED TO LASER RAYS. **Vahl, Johanna (Westfaelische Wilhelms-Univ., Muenster, Ger.). Caries Res., 2: 10-18 (1968).**

The effects of ruby laser irradiation on normal and carious teeth were examined. In sound dentin the craters seen in microrelief under high magnification had relatively sharp edges. The form of these cavity edges resembled those caused by chiseling. The area adjacent to this cavity was scarcely changed by the laser beam. With higher magnification, large particles up to 12 μm dia, with small ones of a dia down to 0.1 μm adhering to them, were observed. Most of the substance hit by the laser beam had melted from the laser bombardment. This melted substance was sprayed out by the pressure from the evaporating material. X-ray crystallographic studies with the Guinier method showed relatively broad reflections. The $d_{(hkl)}$ values showed that the substance was no longer hydroxyapatite. The broadened reflections were thought to be due to lattice defects. The x-ray diffraction results indicated the formation of tricalcium phosphate. This would mean that a high percentage of the analyzed substance comes from the melt. (BBB)

38864 ULTRAVIOLET IRRADIATION IN MEDICINE: OPHTHALMOLOGIC ASPECTS. **Buesseler, John A. (Univ. of Missouri, Columbia). Missouri Med., 65: 293-6 (Apr. 1968).**

Effects of uv radiation of various wavelengths on the human eye are reviewed, with special consideration of space-related aspects. Clinically, the abiotic effect of uv radiation is essentially a photochemical denaturation of proteins. The typical reaction appears only after a latent period of generally 6 to 8 hr and is characteristically manifested by the development of erythema. This can be induced by the wave band from ~180 to 320 mμ. The cellular manifestations are most often an inhibition of mitosis, nuclear fragmentation, and eosinophilic reaction in the nucleus and cytoplasm of the cell. Because the reaction is dependent on the absorption of energy, a critical threshold of wavelength and of intensity of radiation is necessary to excite it. The cornea of the eye, along with the conjunctiva, is selectively affected by uv rays. The lesion in the cornea consists of punctate erosions of the epithelium on the exposed portions of the cornea and conjunctiva. Nucleoprotein absorption of uv radiation is by the DNA and RNA molecules and is manifested in the cornea by the specific absorption by the corneal epithelium of wavelengths of ~265 mμ. The action spectrum of uv keratitis reveals a sharp peak at 288 mμ and falls off to zero at 305 mμ on the long wave

end and reaches a minimum of 260 mμ at the opposite end. The action spectrum of uv keratitis does not correspond exactly to the absorption spectrum of nucleoprotein. The effect of uv radiation on the corneal epithelium therefore, is probably due to absorption either by some substance other than nucleoprotein or by some constituent of nucleoprotein, but not by the molecule as a whole. (BBB)

38865 RADIATION CANCER. Rintala, Aarne (Finnish Red Cross Hospital for Plastic Surgery, Helsinki). Scand. J. Plast. Reconstr. Surg., 1: 5-11(1967).

The diagnosis and treatment of 37 patients with a total of 47 radiation-induced cancers are reported. In the patients with radiation burns the cancer incidence was 20%. Squamous cell carcinoma was the most frequent type, but basal cell carcinoma was also frequent and sarcoma the rarest. Etiologically the benign diseases of the skin and subcutaneous tissues made up the most frequent indications for irradiation. The latent period from irradiation to tumor averaged 23 to 30 yr. Seven of a total of 30 radiation cancer patients treated by plastic surgery died of radiation cancer and 1 of complications of a radiation burn. An inoperable recurrence, in general, appeared immediately. Recurrence was local in 6 instances and only in 1 case attributable to primary metastases. The skin dose of ionizing irradiation causing malignancy was determinable in 5 cases only, in which the mean dose was about 4000 R. In all cases the dose exceeded 1000 R but was usually not exceptionally large. Only one radiation cancer developed as the sequel of a single dose. The cancer incidence, localization of tumor, and various histologic types seen were in accord with earlier reports in the literature. (BBB)

38866 RADIATION CARIES: A RESTORATIVE APPROACH IN THE TERMINAL CANCER PATIENT. Haas, Charles D. (Montefiore Hospital, Bronx, N. Y.). Ann. Dent., 26: 83-6(Sept. 1967).

Dental restoration in patients with terminal cancer and with radioinduced dental injury is described with reference to an illustrative case. The patient, undergoing radiation therapy for a transitional cell carcinoma of the nasopharynx, showed extensive dental decay. She had received 6500 R to the right and left later nasopharynx. She complained of difficulty in swallowing, poor taste in her mouth, xerostomia, and had evidence of slight trismus. Only diseased teeth, and those that would interfere with treatment, were extracted. All attempts were made to preserve the remaining healthy teeth. It was felt that after treatment the patient's oral condition would show a diminished blood supply to the alveolus and mucosa and that the constant pressure from a full prothesis might set up a necrotic situation. Endodontic therapy was instituted; after completion, posts of heavy gauge stainless steel wire were cemented into the root canals, and acrylic crowns fabricated. The maxillary premolars had severe periodontal involvement. The remaining maxillary teeth did not have carious exposure and with Nylon pins were built up in acrylic. Copper bands were cemented on all teeth, and root canal therapy started. Then stainless steel wires were cemented into the root canals, and a processed acrylic splint fabricated. (BBB)

38867 ANEMIAS FOLLOWING IRRADIATION OF THE VERTEBRAL COLUMN. Koerbler, Juraj. Strahlentherapie, 137: 694-9(June 1969). (In German).

During postoperative therapy for a skin basocellular carcinoma of the back, the first sacral vertebra was included in the beam. Almost immediately after the radiation therapy, a not previously existing aplastic anemia was detected in a 71 year old patient. The evolution to myeloblastic leukemia was rapid and death occurred within 7 months. This leukemia must be considered as a radiation induced lesion of the vertebra and not a fortuitous coincidence nor a consequence of a gastrectomy twelve years before. The gastrectomy; however, provoked a slight anemia due to resorption disorders. It can, however, not be excluded that the gastrectomy had an unfavorable influence on the anemia. A too long fractionation scheme with short intervals between the different fractions can cause lesions rather than prevent them in a radiosensitive system like the hematopoietic marrow. (auth)

38868 INCIDENCE OF FISTULA AFTER EMPIRICALLY CARRIED OUT RADIUM DOSAGE. Weise, W.; Reichel, G. (Landesfrauenklinik, Magdeburg, Ger.). Zentralbl. Gynaekol., 90: 494-500(Apr. 6, 1968). (In German).

The relatively increased incidence of late irradiation reactions, particularly of the intestine following empirically determined doses of Ra irradiation, was discussed. Most empirically estimated doses of Ra which were based on schematic plans without taking account of individual requirements for treatment and possible irradiation injury of adjacent organs resulted in suboptimal dosage. Out of 706 patients treated with Ra for ovarian carcinoma, 54 developed fistulas during the post-treatment period. Of these 46% of the fistulas appeared in patients who had been free of carcinoma for at least 5 yr. Irradiation dose rates from the Ra varied greatly (from 25 to 209 R/hr). It was concluded that Ra doses administered should be more precisely estimated to avoid late irradiation injuries and inadequate dose for treatment of the carcinoma. (BBB)

38869 DENTAL FISTULA OF UNUSUAL ORIGIN. Salman, Lawrence; Salman, Steven (New York Univ., N. Y.). N. Y. J. Dent., 38: 168-70(May 1968).

A case of osteoradionecrosis is presented to illustrate the need for a proper history and physical examination before any treatment is instituted to a patient. The patient, referred for the extraction of a lower left cuspid, complained about drainage from the gingiva, mesial to the tooth. Examination revealed a fistulous tract 3 mm mesial to the lower left cuspid from which a purulent discharge could be elicited upon pressure. The past medical history revealed that a squamous cell carcinoma had been excised from the floor of the mouth about 2 yr before, and that radium needles were inserted in the area after surgery. Her physician was consulted and the history confirmed. Further examination by probing the fistula to its base showed that it represented osteomyelitis from the radium. It was found that the fistula originated from an area in the bone that was displaced from the cuspid. The patient was placed on 400,000 units of penicillin G four times daily. The wound was irrigated daily until the fistula closed. The necessity of a history and proper examination is emphasized. In this case, it verified that the problem was not of odontogenic origin, therefore, teeth need not be sacrificed. Extraction of the tooth not only would not have cured the patient, but might have caused a fulminating osteomyelitis. (BBB)

38870 CHEMOTHERAPY IN POLYCYTHEMIA VERA. Stecher, G.; Reinhardt, G. (Univ., Cologne). Acta Genet. Med. Gemellol., 17: 292-302(Jan. 1968).

Effects of ^{32}P treatment of polycythemia vera are described with reference to 210 patients seen over a 15-yr period, and the possible leukemogenic and other late effects are discussed. The response to ^{32}P and Myleran was shown to be different. Myleran caused thrombocytopenia which subsided but reappeared after the next treatment with ^{32}P and persisted. Some patients were started on Myleran after resistance to ^{32}P had developed. The total dose of radiophosphorus per person varied between 23 and 50 mC given over a period of 5 to 10 yr. A characteristic pattern was seen in the development of resistance to therapy. Sooner or later after treatment has been instituted, there is no further effect at all, and the red cell count even rose when therapy with radiophosphorus was continued. This paradoxic response to ^{32}P in some cases was followed by a rapid downhill course of the disease. The sequence of hematological and clinical changes in some of the resistant patients, who were finally treated with Myleran instead of with ^{32}P, was almost identical. The disease almost invariably terminated in either acute or chronic myeloid leukemia or in myelofibrosis with myeloid metaplasia. One case pretreated with urethane, followed by ^{32}P with a total dose of 6 mC, died of chronic myeloid leukemia, which was confirmed by autopsy. In three other cases symptoms were suggestive of chronic myeloid leukemia at an early stage, but diagnostic procedures such as chromosome studies or determination of leukocyte alkaline phosphatase activity were not done at that time. Out of a total of eight patients who died from acute leukemia in the series of 210 cases, only one had received Myleran in addition to radiophosphorus. However, there is no doubt that polycythemia can terminate as leukemia or myelofibrosis without any specific treatment at all. Nevertheless, it should be questioned whether treatment with external radiation, ^{32}P, and/or alkylating agents increases the risk of developing such a fatal outcome or precipitates the onset of it. Evidence for a causal relation has been presented repeatedly. It is concluded that therapy with alkylating agents may be as hazardous as treatment with radiophosphorus or with a combination of both. (BBB)

38871 LATE EFFECTS OF HUMAN LUNG IRRADIATION IN SOME DISREACTIVE CONDITIONS. Mancini, Antonio M.; Tison, Vittorio (Univ., Bologna). Strahlentherapie, 137: 685-93(June 1969).

Independent of the treated diseases (neoplasms) and of the physico-temporal modalities of the radiation therapy, in series of subjects affected by general or pulmonary dysreactive conditions (rheumatic fever, rheumatoid arthritis, lupus erythematosus, bronchial asthma, pulmonary tuberculosis) late radiation pneumonitis of a particular morphology and evolution was observed, different from those presented by subjects with normal tissue reactivity. In fact, the first ones show an interstitial exudative-necrotic phlogosis, while the second ones present only an interstitial productive reaction. These findings, highly significant from the statistical point of view, throw a new light on the hypothesis

of an immunopathic origin of the late pulmonary reaction to ionizing radiation. (auth)

38872 ENZYMATIC AND SCINTIGRAPHIC CHANGES DURING RADIOTHERAPY OF LIVER METASTASES. Kaercher, Karl Heinz (Univ., Heidelberg). Strahlentherapie, 137: 540-5(May 1969). (In German).

In patients with primary and secondary liver tumors localized radiation therapy is applied and the effects on serum enzymes and liver scans are described. The diagnostic importance of the procedure is discussed. (H.B.G.)

38873 VESICOURETERAL REFLUX IN PATIENTS IRRADIATED FOR UTERINE NEOPLASMS. Cossu, F. (Univ., Cagliari, Italy); Tunesi, G. Ann. Radiol. Diagn., 40: 166-76(1967). (In Italian).

The incidence of the vesicoureteral reflux during radiotherapy of cancer of the uterine portio was reported following the examination of 48 patients. The study, that was performed utilizing periodic cystographic and cystoscopic controls, revealed that the vesicoureteral reflux became obvious when evident signs of post-irradiation reaction involving the bladder coexisted. It was concluded that the vesicoureteral reflux should be included among the complications of radiological treatment of cancer of the uterus, and attention was drawn to the importance that this occurrence must have in the diffusion of inflammation by the ascending route. (auth)

38874 RADIATION-INDUCED CHANGES IN AXILLARY LYMPH NODES IN BREAST CANCER TREATED PREOPERATIVELY WITH X RAYS. Laskowski, J.; Lysakowska, J. (Inst. of Oncology, Warsaw). Pol. Med. J., 7: 896-907(1968).

On the basis of surgical specimens from 195 patients treated preoperatively for breast cancer with x rays, changes in the lymphoreticular tissue induced by x rays were examined. A combination of morphologic changes, seen in the site termed the postneoplastic focus, occurring characteristically in axillary lymph nodes treated with high-doses of x rays was described. This focus in the lymph node offers morphologic proof of complete sterilization of the axillary lymph nodes by ionizing radiation. Radiation-induced changes in the malignant tissue of metastases had features qualitatively similar to those of the primary tumor. The degree of radiation injury to breast cancer and its metastases was similar; however, in 1/3 of the cases with marked damage to the primary tumor in the mammary gland the metastases in the lymph nodes remained unchanged. It was confirmed that a large number of lymph nodes containing metastases, as well as infiltration of the capsule of the lymph node and spread of the neoplasm to the surrounding tissue, should be regarded as prognostically unfavorable. (BBB)

38875 INVESTIGATIONS ON THE EFFECT OF MICROWAVES ON THE EYE. Majewska, K. (Postgraduate Medical Education Center, Warsaw). Pol. Med. J., 7: 989-94(1968).

Translated from Klin. Oczna, 38: No. 2(1968).

Two groups of subjects comprising 200 persons each were examined. Group I comprised workers exposed to the action of microwaves of 2.8 to 50 cm wavelength. Group II included controls, who had never had any contact with microwaves. Both groups were matched with regard to age. The results of investigations were elaborated statistically and showed, that there exists a possibility of harmful effect of microwave radiation even at intensities tolerated in the regulations of work safety, if the exposure to microwaves is sufficiently long (over 4 to 5 years). (auth)

38876 MORPHOLOGY OF RADIATION-INDUCED CHANGES IN BREAST CANCER. Lysakowska, J.; Laskowski, J. (Inst. of Oncology, Warsaw). Pol. Med. J., 7: 880-95(1968).

In 200 cases of breast cancer treated preoperatively by high doses of x rays, the surgical specimens were examined macroscopically and microscopically. The skin after irradiation was thin, wrinkled, flaccid, and desquamating, its color was light- or dark-brown, and it often contained a prominent network of dilated blood vessels. The glandular tissue of the breast was of rubber-like consistency approaching that encountered in mastopathy. In cross-sections, intensely yellow fat tissue prevailed over glandular tissue, which appeared as white glistening bands of fibrous connective tissue. Often, cysts corresponding to dilated glandular ducts were visible in it. Microscopic radiation-induced changes in the skin included thinning of the epidermis with excessive keratinization and desquamation, flattening of the papillae, and atrophy of the skin appendages. In the connective tissue, varying degrees of homogenization, hyalinization, and degeneration of the elastic fibers were observed. Against this background were seen numerous dilated capillaries, larger vessels with hyalinized walls, small aggregations of inflammatory cells, and isolated scattered large, sometimes multinuclear cells with pale eosinophilic cytoplasm, representing degenerated forms of fibroblasts. Colostrum-like cells also appeared frequently; they had irregular hyperchromatic or even disintegrating nuclei and were arranged in chains or clusters in the fissures of connective tissue. They resembled infiltrating malignant cells in mammary cancer. Resorptive cells were numerous, appearing as aggregations of pale, eosinophil histiocytes loaded with granules of brown pigment. Often foreign body giant cells associated with laminar calcifications were found there. In 80% of cases the malignant tissue remained active after radiotherapy, showing almost no morphologic evidence of radiation-induced injury. It was concluded that radiosensitivity of various types of mammary cancer cannot be estimated on the basis of histological findings in cases subjected to radiotherapy. (BBB)

38877 SECONDARY IRRADIATION NEPHRITIS. Campanacci, L.; Patrese, P.; Romagnoli, G. F.; Okolicsanyi, L. Minerva Med., 59: 4091-2(Sept. 30, 1968). (In Italian).

A minor kidney pathology found in 25% of the patients exposed to high energy radiotherapy is briefly described. Generally the pathology consists of an asymptomatic nephritis or nephritis resulting in few symptoms. Some indications of decreased tubular function are evident. (J.S.R.)

38878 EFFECT OF DIAGNOSTIC RADIATION UPON THE HUMAN FETUS. FOLLOW-UP STUDY OF 152 CHILDREN EXPOSED TO IRRADIATION DURING THE FIRST 4 MONTHS OF FETAL LIFE DUE TO X-RAY EXAMINATION OF THE MATERNAL ABDOMEN. Noekkentved, Kirsten. Copenhagen, Munksgaard, 1968. 226p.

Somatic changes, in particular congenital malformations, were investigated in children irradiated during intrauterine life. One hundred fifty-two mothers who had had abdominal x-ray examinations within the first four months of pregnancy during the years 1937 to 1960 were found through the files of a provincial hospital. The children irradiated in utero were examined and compared with 141 control children selected from among their siblings. A statistical analysis of the material showed that no teratogenic effect could be demonstrated, but as remarkably many premature children and children of small height at the time of examination were found among those irradiated in the second month of fetal life, a somatic effect of irradiation at that time cannot be excluded. Among factors that might affect the health and development of the children, social conditions and medication to the mothers during pregnancy were found to be the most important. (Denmark)

Radiation Effects on Plants

Refer also to abstracts 38171, 38454, 38471, 38518, 38534–38536, 38545–38547, and 38551.

38879 THE EFFECT OF LOW-LEVEL ACUTE GAMMA RADIATION ON THE GROWTH OF MARCHANTIA POLYMORPHA L. ORIGINATING FROM VARIOUS ECOLOGICAL POPULATIONS. Sarosiek, J.; Wozakowska-Natkaniec, H. (Univ., Wroclaw). Acta Soc. Bot. Pol., 37: 413-26(1968).

Populations of Marchantia polymorpha growing in the Sudetes Mountains where there are various degrees of natural radioactivity were compared to normal populations in their radiosensitivity. Sprouted gemmae from five populations were exposed to from 500 to 10,000 mR of ^{60}Co γ radiation with intensities of 100 and 1000 mR/hr. Thalli were measured at various times after irradiation. Gemmae from populations naturally occurring in areas where the intensity of radioactivity is 0.28 mR/hr did not differ in their radiosensitivity from those derived from populations from habitats with no detectable radioactivity. The gemmae from populations whose habitats had higher intensities of radiation (up to 0.86 mR/hr) were more resistant to γ radiation. (M.M.B.)

38880 DELAYED GERMINATION IN GAMMA-RAYED DRY SEEDS OF JUTE (CORCHORUS SP.). Sen, Subir; Ghosh, Nabinananda (Univ. of Kalyani, Mohanpur, India). Sci. Cult. (Calcutta), 34: 346-7(Aug. 1968).

Dry seeds of the variety JRO-632; JRO-620 and Sudan of Corchorus olitorius L.; Fanduk, JRC-212, and D-154 of C. capsularis L. with 5 to 8% moisture content were γ irradiated with acute doses of 40, 60, 80, 100, 120, and 140 kR (^{60}Co at 3,000 R/min). The irradiated seeds were tested for germination two weeks after treatment. It was found that dry seeds of C. capsularis varieties exhibited a highly radiosensitive germination response; the response was attributed to effects of acute γ radiation or moisture content during postirradiation storage. The seeds of C. olitorius, and control seeds of C. capsularis did not exhibit radiosensitive or moisture content-sensitive germination responses. (C.O.)

38881 THE INDUCTION AND REPAIR OF RADIATION DAMAGE IN CHLAMYDOMONAS. Davies, D. Roy (Wantage Research Lab., Eng.). Curr. Top. Radiat. Res., 5: 75-113 (1969).

Studies of the comparative sensitivities to uv and γ radiation of haploid and diploid cell stages of Chlamydomonas reinhardii have shown that the diploids can be either more or less resistant than the haploids; this has necessitated a reconsideration of the basis for the differential response of haploid and diploid cells. The various phases of the cell cycle of diploid cells have been shown to differ in their response to γ and uv radiation, and in the case of uv this has been shown to be due to a change in dark-repair activities. Whereas the photoreactivating system remains active, control mechanisms limit the level of dark repair activity at certain specific times. This limitation may be related to the genetic recombination which occurs in these cells. Radiosensitive mutants have been isolated; with these an analysis has been made of the genetic control of the repair of uv-induced lethal and mutational damage, and of the nature of uv-induced reversion to prototrophy at one particular locus. One mutant is of particular interest in that it shows a greater sensitivity to sparsely ionizing radiation when irradiated in the absence than in the presence of oxygen. Detailed analyses have been made of this and of a revertant strain which shows completely opposite effects of oxygen at different developmental stages. The effect of fractionating a given dose of sparsely and densely ionizing radiations has been discussed and the relation of dose rate effects to repair activities considered. Finally the comparative response of haploid and diploid cells to radiations of different LET has been described. (auth)

38882 QUANTITATIVE REGULATIRITIES IN THE POST-IRRADIATION RECOVERY OF YEAST CELLS DURING THE ACTION OF HIGH-ENERGY, HEAVY, ^{12}C IONS. Benevolenskii, V. N.; Grigor'ev, Yu. G.; Kudryashov, E. I.; Marennyi, A. M.; Popov, V. I.; Ryzhov, N. I. (Inst. of Medico-Biological Problems, Moscow). Dokl. Akad. Nauk SSSR, 185: 452-5(Mar. 11, 1969). (In Russian).

Diploid cells of Saccharomyces vini of strain MEGRI 139-B were irradiated with ^{12}C ions having an energy of 5 MeV/nucleon. The cells were irradiated in the form of a monolayer on a surface of cold agar. The degree of damage was determined from the appearance of the microcolony after growing on agar wort. Surviving cells were taken as the normal disk-shaped colonies (class S). Damaged cells were taken as 5-cell to normal (class M_1) and 2- to 4-cell colonies (class M_2). Dead cells without division were the individual cells (class M_3). In each case a total of 200 microcolonies were observed. At doses of 40 and 60 kilorads, cell survival increased over a definite period of time, and then reached a plateau. The postradiation recovery in the cells was by a mechanism of gradual recovery. The magnitude of the irreversible component of radiation damage was determined. The rate of recovery at all irradiation doses was exponential. On irradiating the cells with ^{12}C ions, the amount of irreversible damage was greater and the recovery was less than on irradiating with γ- or x rays. (TTT)

38883 X-RAY IRRADIATION TO DISSECTED EMBRYOS OF RICE AND THEIR MUTATION SPECTRUM. Bhaduri, P. N.; Shome, A. (Burdwan Univ., India). Curr. Sci. (India), 38: 297-8(June 20, 1969).

In order to study the effects of x radiation on rice embryos without the masking effects of maternal tissue and endosperm, the embryos were excised and then irradiated. Mature embryos received doses of 10 to 35 KR and immature embryos 1.5 to 16 KR. The mutation frequencies, differential radiosensitivity and germination rate were studied in the irradiated embryos first in vitro, then under field conditions. The germination rate was unaltered, but the radiosensitivity of plants and the mutation frequencies varied with the different varieties of rice used. (E.R.B.)

38884 FULL ANALYSIS OF A POTATO CHIMERA. Howard, H. W. (Plant Breeding Inst., Cambridge, Eng.). Genetica, 40: 233-41(1969).

In the variety Arran Victory, that has purple tubers, there was found a tuber half purple and half pink. The pink half produced a plant that had pink tubers with small purple patches. X-irradiation of these tubers gave plants that had about 5% of pink tubers without the purple patches. Breeding and eye-excision experiments showed that the pink tubers with small purple patches were periclinal chimeras in which gene P was lost from L1, L2 plus L3 still having gene P as in normal Arran Victory. The pink tubers without the purple patches had no gene P in L1, L2, and L3. The chimerical pink tubers had purple sprouts, the full pink tubers pink sprouts. The pigmented layer in the tubers of Arran Victory is the phelloderm (secondary cortex), not the primary outer cortex. (auth)

38885 ACTION OF TWO ALKYLATING AGENTS (METHANE ETHYL SULFONATE AND NITROGENOUS MUSTARD) ON THE TISSUES OF JERUSALEM ARTICHOKE TISSUES GROWN IN VITRO. PROTECTION OF THE TISSUES BY CYSTEAMINE AND RESTORATION BY KINETIN. Jonard, Robert (Laboratoire de Biologie Cellulaire, Paris). Radiat. Bot., 8: 467-71 (Dec. 1968). (In French).

Methane ethyl sulfonate and nitrogenous mustard cause an inhibition of the proliferation of the Jerusalem artichoke tissues grown in vitro. Cysteamine which protects the tissues from the effect of x rays, also acts in a protective way as regards the toxic effect of nitrogenous mustard. Kinetin, which is an efficient radiorestorer for the tissues, restores proliferation of samples subjected to the effect of nitrogenous mustard. (auth) (UK)

38886 RESPONSE TO CHRONIC GAMMA IRRADIATION OF TWENTY-FOUR PEA GENOTYPES. Monti, L. M.; Donini, B. (CNEN, Rome). Radiat. Bot., 8: 473-87(Dec. 1968).

Twenty-four pea genotypes were chronically exposed in the gamma field (^{60}Co source; 350 Ci) to 34 different exposure rates ranging from 5 to 200 R/d. The irradiation responses were evaluated by: (i) reduction of plant height, (ii) the highest exposure rate at which the plants were still able to flower, (iii) pollen abortion, and (iv) pod fertility. Each of the parameters used showed a clear dose-effect relationship but revealed a differential radiosensitivity among the 24 genotypes. Use of the first two parameters was influenced by the respective controls, because of the different growth rate and flowering time of the investigated lines. Also pod fertility was not a suitable parameter because of the low number of ovules and seeds per pod in pea. Pollen abortion proved to be the best parameter used because (i) the analysis is performed at a cellular level; (ii) it does not change in flowers collected at different times; and (iii) it is very sensitive to small increases in the exposure rate. A positive correlation was found between pollen abortion and earliness, probably because of the lower exposure received by the faster dividing cells of the early lines. Except for a possible influence of the factor A (presence of anthocyanin) on the response to irradiation, no other influence was found between radiosensitivity and the recessive marker genes present in the material; nor was any difference found between the mother line Parvuus and the six induced mutant genotypes analyzed. (auth) (UK)

38887 EFFECTS OF GAMMA RADIATION ON THE SUCCESSIVE STAGES OF DEVELOPMENT OF THE MALE GAMETOPHYTE OF TOBACCO. Devreux, M. (Communaute Europeenne de l'Energie Atomique, Geneva); Saccardo, F. Radiat. Bot., 8: 365-74(Dec. 1968). (In French).

The effects of three exposures to gamma rays (1, 2, 4 kR) on the successive developmental stages of the male gametophyte of tobacco were examined in order to investigate radiosensitivity. The radiobiological parameters considered were: pollen fertility of the flowers irradiated at the bud stage; the embryonic development 7, 9 and 11 days after hand pollination with pollen coming from irradiated floral buds; seed-setting; mean weight of 100 seeds; germination of seeds; cotyledon abnormalities and aberrant mitotic anaphases in the root tips of the M_1 seedlings. All these analyses show that radiosensitivity is low in the early microspore stages and increases up to the haploid mitosis. Afterwards, during the whole binucleate stage, radiosensitivity decreases to a minimum some days before anthesis (flower bud size: 51 mm) and increases again during the last two days. The changes in radiosensitivity seem to be related to the DNA synthesis during the microspore stage, whilst for the binucleate stages sensitivity may be related to the synthesis and the hydrolysis of polysaccharides in the cytoplasm of the pollen grain. Because of the persistence of chromosomal aberrations in root tips of the seedlings obtained from irradiated microspores and pollen grains, it appeared that by this type of radiation treatment in tobacco it is not possible to obtain plants completely heterozygous for some induced mutations. (auth) (UK)

38888 THE GROWTH OF MICROSPORUM GYPSEUM FOLLOWING THE EFFECT OF BETA RADIATIONS ON FUNGUS AND CULTURE MEDIUM. Krause, H. (Technische Hochschule, Aachen). Hautarzt, 18: 351-5(Aug. 1967). (In German).

Effect of prior β irradiation of Microsporum gypseum and the culture media on growth of the fungus were studied. Irradiation of the fungus prior to its transfer to agar resulted in inhibition of growth of the fungus which reached a maximum on day 6 of growth. The growth inhibition increased with increasing amounts of preirradiation. When the spores were irradiated after inoculation or at the same time as the culture medium was irradiated, then the growth inhibition was increased, and the lethal β irradiation dose decreased from a value of 1.7×10^6 to 2.1×10^5 rep. If the culture medium was irradiated with a high dose immediately

before it was inoculated, a fungistatic effect was observed for 3 days afterward. It was concluded that this growth inhibition was due to formation of some unstable factor that had a radiosensitizing effect which increased radiosensitivity of the spores during their germination. (BBB)

38889 ACTIONS OF ACUTE GAMMA RADIATION ON EXCISED WHEAT LEAF TISSUE. I. RADIORESISTANCE OF SENESCENCE AND ESTABLISHING CRITERIA OF DEATH FROM STUDIES OF CHLOROPHYLL LOSS. Haber, Alan H.; Walne, Patricia L. (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville). Radiat. Bot., 8: 389-97(Dec. 1968).

At a developmental stage when both cell division and expansion had already ceased, apical portions of the first foliage leaf from three varieties of wheat were excised and given various acute doses of gamma radiation. Four criteria are suggested for γ-radiation-induced death with reference to chlorophyll content: (1) photodestruction of chlorophyll in the light, (2) inhibition of chlorophyll decay in darkness, (3) loss of chemical regulation of chlorophyll decay, and (4) abolition of the normal temperature optimum for chlorophyll decay in darkness. By all four-criteria γ-radiation-induced death occurs only after acute doses in excess of a few hundred thousand rads even in the most radiosensitive variety. The possible similarity of this γ-radiation-induced lethality to other forms of lethality in excised leaf tissue is discussed. Sublethal doses of a few hundred thousand rads, which greatly affect growth and development of leaf tissue growing with cell divisions, have little or no significant effect on senescence in the excised leaf tissue system. This ineffectiveness contrasts with the effectiveness of chemical and temperature treatments. The absence of cell division and expansion prevents any acceleration of senescence from (a) genic imbalance resulting from chromosome breakage in dividing cells, (b) radiation-induced mitotic inhibition, and (c) radiation-induced growth inhibition, effects which occur after irradiation of tissue growing with cell divisions. The results indicate that senescence (when uncomplicated by the above three typical radiation effects) can be remarkably insensitive to ionizing radiation. (auth) (UK)

38890 ACTIONS OF ACUTE GAMMA RADIATION ON EXCISED WHEAT LEAF TISSUE. II. IMMEDIATE LETHAL DOSE EFFECTS ON CHLOROPLAST ULTRASTRUCTURE AND SUBSEQUENT RETARDATION OF NORMAL DISINTEGRATION IN DARKNESS. Walne, Patricia L.; Haber, Alan H. (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville). Radiat. Bot., 8: 399-406(Dec. 1968).

Apical portions of wheat leaves were excised and given various acute, lethal doses of γ radiation. Although extremely high doses (2 Mrad or more) produced immediate, detectable damage to chloroplast ultrastructure, 1 Mrad, despite its lethality, produced little or no immediate detectable damage to chloroplast ultrastructure. The 1 Mrad dose greatly retards the normal physiological deterioration of chloroplast structure that occurs in non-γ-irradiated leaf tips in darkness. The 1 Mrad dose also preserves the capacity of the leaf tissue to emit glow curves upon warming in darkness after illumination at −196°C, but prevents the normal emission of delayed light at room temperature after illumination. This indicates normal capacity to put energy from the photoreaction into electron traps in the photosynthetic pigment system exclusive of subsequent enzyme reactions. It indicates, further, an absence of normal energy storage in the photosynthetic system coupled to the enzymatic reactions of electron transport. The 2 Mrad dose, which produces immediate ultrastructural damage, also destroys the capacity to emit glow curves. At the ultrastructural level responses of other cellular organelles to the lethal doses were similar to the responses of chloroplasts. The effects of 1 Mrad on maintaining ultrastructure in darkness, which have parallel effects on chlorophyll retention, also have parallel effects on retention of insoluble nitrogen. (auth) (UK)

Radiation Effects on Microorganisms

Refer also to abstracts 38458, 38461, 38469, 38473, 38476, 38485, 38490, 38533, 38538, 38548, 38621–38624, 38906, and 38911.

38891 AN ADENINE-REQUIRING MUTANT OF AZOTOBACTER WITH MODIFIED RESPONSE TO ULTRAVIOLET AND NITROSOGUANIDINE. Roy, Pampa; Mishra, A. K. (Bose Inst., Calcutta). Sci. Cult. (Calcutta), 35: 33-4(Jan. 1969).

An N-methyl-N′-nitro-N-nitrosoguanidine(NTG)-induced adenine-requiring mutant of Azotobacter vinelandii designated as Ad-116 was investigated with respect to its sensitivity to uv radiation and NTG. It was determined that the mutant Ad-116 was more sensitive to uv radiation and more resistant to NTG than was the parent strain. (E.R.B.)

38892 SOME RECENT STUDIES IN MOLECULAR RADIOBIOLOGY. Zimmer, K. G. (Kernforschungzentrum, Karlsruhe, Ger.). Curr. Top. Radiat. Res., 5: 1-38(1969).

The basic facts and ideas that originated studies in molecular radiobiology are discussed and the limitations of the early research approaches are considered. Following this, results of studies concerned with temperature dependence of radiation effects in bacteriophage and their infectious DNA, and in RNAase; the breakage and cross-linking of DNA in irradiated phage; electron spin resonance studies on phage and its DNA, and on monocrystals of DNA constituents; actions of atomic hydrogen on phage and its infectious DNA, and on RNAase; and actions of vacuum-uv radiation on infectious DNA isolated from phage ϕ X 174 are discussed. (C.O.)

38893 RESISTANCE OF VEGETATIVE CELLS AND MICROCYSTS OF MYXOCOCCUS XANTHUS. Sudo, Sara Z.; Dworkin, Martin (Univ. of Minnesota, Minneapolis). J. Bacteriol., 98: 883-7(June 1969).

The resistance of vegetative cells and of microcysts of Myxococcus xanthus to several destructive agents was compared. Fruiting-body microcysts were 300 times more resistant to 60°C, 5.4 times more resistant to ultraviolet light, and 19.3 times more resistant to sonic vibration than were vegetative cells. Whereas resistance to sonic vibration developed during the conversion of rods to refractile spheres, resistance to heat did not appear until after the conversion was complete. Both vegetative cells and microcysts of the yellow variant of this strain were more resistant to ultraviolet irradiation than was the tan variant. (auth)

38894 ACTIVATION OF VIRUS SYNTHESIS IN POLYOMA-TRANSFORMED CELLS. Fogel, Marian; Sachs, Leo (Weizmann Inst. of Science, Rehovoth, Israel). Virology, 37: 327-34(Mar. 1969).

The activation of virus synthesis was studied in two polyoma virus (PV) transformed cell lines obtained after infection of cell cultures from rat embryo muscles with a small plaque (SP) and a large plaque (LP) strain of PV. The isolation of clones from these two cell lines in the presence of anti-PV antiserum has shown, that although there was no detectable virus synthesis in 30 clones derived from the SP transformed line, 92 out of 100 clones derived from the LP transformed line continued to produce virus synthesizing cells. The virus produced by the virus synthesizing cells was of the LP type. The results indicate, that there can be a spontaneous activation of virus synthesis in clones from the LP transformed line, that this ability for spontaneous activation can be transmitted to progeny clones, and that clones with spontaneous activation can segregate some clones that appear to be no longer activable under the same conditions. The spontaneous activation of virus synthesis generally occurred in about one in 10^4 cells. It was shown that the frequency of virus synthesizing cells in clones with spontaneous activation can be increased about 100 fold by x irradiation, and in multinucleate cells formed after fusion of LP transformed and normal mouse cells with Sendai virus. (auth)

38895 LASER-INDUCED ACOUSTIC BREAKAGE OF TOBACCO MOSAIC VIRUS. Hamrick, P. E.; Cleary, S. F. (Medical Coll. of Virginia, Richmond). Nature (London), 222: 1201-2(June 21,'1969).

A reply is made to the observations of Carome (Nature 221: 660 (1969)) on the earlier communication of the authors (Nature 220: 909 (1968)) on this subject. Carome suggested that the observed effects may have been caused by complicating factors related to pulse reflections and/or cavitation of the suspending medium. The authors have considered the various possibilities, but were unable to attribute the effects to other than the hydrodynamical stress produced by the extreme velocity gradients of the acoustic pulses. (UK)

38896 TOXICITY OF SPORES OF CLOSTRIDIUM BOTULINUM STRAIN 33 A IN IRRADIATED GROUND BEEF. Fernandez, E.; Tang, T.; Grecz, N. (Illinois Inst. of Tech., Chicago). J. Gen. Microbiol., 56: 15-21(Apr. 1969).

Spores (4×10^5/lb) of C. botulinum strain 33 A, a highly radiation-resistant strain, were incorporated into ground beef and sealed in thermal-death time cans. The samples were then irradiated with ^{60}Co to 4.5 Mrad at a dose rate of 0.3 Mrad/hr. The temperatures during irradiation were controlled at −25°, 0°, and +25°. During subsequent incubation of irradiated samples at 30° for 10 months, periodic analyses showed no viable spores. Toxin was tested on nonhomogenized samples and samples homogenized in a tissue grinder. In samples irradiated at −25° and 0° and in unirradiated unincubated controls, four minimal lethal doses (MLD) of toxin were found in nonhomogenized samples immediately after irradiation. The toxin titer of irradiated samples gradually diminished to half of its initial value at the end of 10

months at 30°. In identical sets of homogenized irradiated samples, 8 MLD were found initially and the titer increased to 44 MLD after 2 weeks to 4 months of incubation at 30°. Thereafter, the toxin titer slowly deteriorated to ~25 MLD at the end of 10 months. Samples irradiated at 25° exhibited a definite increase in toxin titer even immediately after irradiation, suggesting new toxin synthesis either during or after irradiation. The toxin titer in homogenized samples reached 64 MLD after 2 months at 30° and thereafter slowly diminished to 31 MLD at 10 months. Toxin titers in radiation-damaged spores were small in comparison to unirradiated C. botulinum growing in beef which reached 1000 to 5000 MLD in 2 days at 30°. (BBB)

38897 STERILIZATION AND DISINFECTION: OBJECTIVES AND PERSPECTIVES. Kelsey, J. C. (Central Public Health Lab., London). Ann. Roy. Coll. Surg. Engl., 44: 214-23(Apr. 1969).

Use of ionizing radiations, particularly ^{60}Co γ rays and linear accelerator β rays, for sterilization is reviewed, along with other methods of disinfection. Test systems for evaluating the degree of sterilization are outlined. The methods need to be tested regularly to ensure that the right conditions have been applied to every part of the load to be treated. Physical measurements include the use of thermocouples for checking the temperature achieved in wet and dry heat sterilization and radiometers for checking the dose of irradiation applied. Chemical indicators may also be used. There are radiosensitive dyes which give a qualitative indication that radiation has been applied rather than a quantitative indication of the dose. Bacterial spore preparations include Clostridium tetani for dry heat, Bacillus stearothermophilus for wet heat, Bacillus pumulus for irradiation, and a pigmented strain of Bacillus subtilis (B. globigii) for use with ethylene oxide. In general, physical or chemical methods are preferred, as they are, when properly used, reliable and informative. Ionizing radiations are increasingly being used for sterilization. The most usual techniques employ γ rays from a radioactive source, for example ^{60}Co, or β particles from a linear accelerator. Good penetration can be obtained and closed packs can be used. There is no residual radioactivity but some materials, such as glass, may be damaged. The dose needed to achieve sterility has not yet been finally agreed upon, but 2.5 Mrad is generally considered adequate for most articles. (BBB)

38898 INACTIVATION OF SINGLE- AND DOUBLE-STRANDED RIBONUCLEIC ACID OF ENCEPHALOMYOCARDITIS VIRUS BY ULTRAVIOLET LIGHT. Zavadova, Z.; Gresland, L.; Rosenbergova, M. (Inst. of Virology, Bratislava). Acta Virol. (Prague), 12: 515-22(Nov. 1968).

A comparison was made of the inactivation of single- and double-strand RNA (ss- and ds-RNA) by uv irradiation (2537 Å). Infectivity of ss-RNA of encephalomyocarditis (EMC) virus was inactivated at a slightly higher rate (20% greater) than the whole virus. Both virus and ss-RNA followed a simple exponential dependence of the surviving fraction after uv irradiation. Their survival was not influenced by addition of caffeine to the agar medium of infected cultures and was not dependent on the age of L cell cultures used for infectivity assay. The ds-RNA was inactivated at a $\frac{1}{4}$ to $\frac{1}{6}$ lower rate than ss-RNA and the inactivation curve usually showed a small initial concave deflection. The survival of ds-RNA after uv irradiation was decreased by caffeine and varied with the age of cultures used for plating. A host-cell repair mechanism may explain this result. (BBB)

38899 HOST-CELL REPAIR OF ULTRAVIOLET-IRRADIATED PSEUDORABIES VIRUS IN CHICK EMBRYO CELLS. Zavadova, Z.; Zavada, J. (Inst. of Vriology, Bratislava). Acta Virol. (Prague), 12: 507-14(Nov. 1968).

Experiments were conducted to determine whether host-cell repair (HCR) could be demonstrated in a DNA-containing animal virus after uv irradiation and plating in chick cell cultures. Pseudorabies virus, which shows a 2-component inactivation curve was examined. The first component (~to 10^{-2} survival) was inactivated by 2537 Å uv irradiation at 190 erg/mm^2 per lethal hit; the second component apparently was 20 times more resistant. Linear dependence of plaque counts on the concentration of irradiated virus shows that this deviation is not due to multiplicity reactivation. Addition of caffeine (0.5 mg/ml) to the agar overlay after virus adsorption significantly reduced the survival of irradiated virus, but acriflavine (0.5 μg/ml) had little or no effect. At higher uv doses, the surviving fraction depended on the age of cell culture. On the other hand, treatment of infected cultures with puromycin (5 μg/ml) increased the surviving fraction. These results suggest that HCR may explain the high resistance of the slower component of the uv-inactivation curve of pseudorabies virus. (BBB)

38900 THE RADIOSENSITIZATION OF MICROCOCCUS SODONENSIS BY N-ETHYL MALEIMIDE. Mullenger, L. (Royal Military Coll. of Science, Swindon, Eng.); Ormerod, M. G. Int. J. Radiat. Biol., 15: 259-69(1969).

Radiosensitization of the bacterium Micrococcus sodonensis by N-ethyl maleimide (NEM) has been obtained by administering the sensitizer before, during, and after irradiation. It has been shown that there are three different mechanisms of sensitization by NEM: caused by an intracellular reaction, presumably with sulphydryl groups, caused by the reaction of NEM with a reducing species, probably with the electron, to give a short-lived toxic product, and caused by interference with the post-irradiation repair processes. The experiments also indicate that NEM is able to penetrate the cell while another sulphydryl poison, iodoacetamide, cannot. This accounts for some of the difference in the mode of action of these two radiosensitizers. (auth)

38901 RADIOSENSITIZATION BY POTASSIUM IODATE AND RELATED COMPOUNDS. Kada, T. (National Inst. of Genetics, Misima, Japan). Int. J. Radiat. Biol., 15: 271-4(1969).

Air-saturated suspensions of Escherichia coli were γ-irradiated at a dose rate of 167 R/min. Just before irradiation one volume of reagent solution was combined with nine volumes of bacterial suspension. Reagents used were potassium bromate, potassium chlorate, potassium iodate, trisodium paraperiodate, and potassium periodate. Effects on colony-forming ability were observed. Graphs are presented to show effects of reagents on radiolethality of Escherichia coli and effects of pH on radiosensitization of Escherichia coli by potassium iodate. Among the compounds tested, iodate, periodate, and paraperiodates possessed marked radiosensitizing capacities at concentrations at which they were not toxic to non-irradiated bacteria. (H.L.W.)

Radiosterilization and Radiopreservation

Refer also to abstracts 37976, 38182, 38472, and 38896.

38902 (AECD/RB-9) IRRADIATION PRESERVATION AND DISINFESTATION OF CERTAIN TROPICAL FRUITS. A Comprehensive Report on IAEA/FAO Research Contract No. 361/RI/RB on BANANA and MANGO. Hossain, M. M.; Hamid, M. A. (Atomic Energy Centre, Dacca (Pakistan)). May 1968. 36p. Dep.

Extension of storage life of bananas and mango fruit by γ irradiation was investigated. Bananas were exposed to graduated doses of γ radiation ranging from 10 to 100 Krad. Observations were made during storage at temperatures of 25 to 35°C and relative humidities of 65 to 85%. Ripening was delayed by all radiation doses. Skin damage was minimized when the fruit was irradiated in a nitrogen atmosphere or treated with a skin coating containing acetylated monoglyceride. Bacterial counts were reduced on bananas exposed to 40 Krad doses. No appreciable changes were observed in the color, flavor, taste, or texture of irradiated bananas. Mango fruit irradiated at doses of 10, 20, and 30 Krad did not show a delay of ripening, but spoilage was slightly reduced. Doses of 2,000 R and above killed the larval and pupal stages of the mango fruit fly Chaetodaccus ferrugienus. (C.H.)

38903 (N-68-36915) FOOD PRESERVATION BY IRRADIATION. PART 7. INVESTIGATIONS CARRIED OUT WITH TWO VARIETIES (ALAVA AND GINEKE) OF SPANISH POTATOES. Garcia de Mateos Lopez, A.; Rivas Garcia, A.; Ortin Sune, N.; del Val Cob, M. (Junta de Energia Nuclear, Madrid (Spain). Seccion de Isotopos). 1967. 28p. (In Spanish and English). (JEN-189-SI/I-18). CFSTI.

Radiation doses from 5 to 50 Krad were used and during a twelve months' period the effects of γ radiation on the weight loss, sprouting, and spoilage control, texture, ascorbic acid, and total carbohydrate content of potatoes were studied. Tests of sprouting in field conditions are described. The dose of 8000 rads provided excellent control of sprouting regardless of variety. (STAR)

38904 ORGANOLEPTIC EVALUATION OF LOW-DOSE IRRADIATED CHICKEN STORED UNDER REFRIGERATION CONDITIONS. MacLeod, C. M.; Farmer, F. A.; Neilson, H. R. (McGill Univ., Montreal). Food Technol., 23: No. 7, 104-8 (July 1969).

Six expert panelists correctly selected and identified the unmatched sample in triangle tests in which odor, taste, color, and texture of γ-irradiated stored cooked chicken were compared with non-irradiated, non-stored chicken. This was true for samples of white and dark chicken stored for 0, 1, 2, or 3 wk, at 6.7°C or 1.1°C and irradiated at 0.46 Mrad. Similar results were observed when odor and color of raw chicken were the criteria for

comparison but, since only wings were used, no comparison was made of white and dark meat. The panel was even more successful in selecting and identifying the unmatched sample when a dose of 0.69 Mrad was used for cooked chicken. For the tests using raw chicken, the difference between the two dose levels was not seen. Although panelists who correctly selected and identified the unmatched sample of cooked chicken said they disliked the irradiation flavor, it is concluded that these panelists may have been prejudiced in their judgment. Those who correctly selected but could not identify the unmatched sample did not dislike the irradiated one, while those who did not correctly select and identify the sample said they disliked the chicken they thought was irradiated. No dislike was expressed for irradiated samples of raw chicken. (auth)

38905 LYOPHILIZED ROENTGEN-IRRADIATED BONE TRANSPLANT IN THE ORTHOPEDIC AND TRAUMATOLOGIC PRACTICE. Arct, W.; Klimek, S. Beitr. Orthop. Traumatol., 14: 600-1(Oct. 1967). (In German).

Preserved bones were used in 70 cases during a period of two years. The results obtained indicate that the use of lyophilized γ-irradiated bone transplants is uncomplicated and gives good results. (J.S.R.)

38906 SOIL STERILIZATION WITH IONIZING RADIATION. Mueller, H. P. (Univ., Bonn). Atompraxis, 14: 480-4(Nov.-Dec. 1968). (In German).

The application of several types of ionizing radiation (neutron, gamma, x-rays) in biologically active soils of different composition leads to a complete elimination of the microflore without altering disadvantageously the soil solution, the soil structure, the organic matter, the soil enzymes and without affecting plant growth. Due to these properties ionizing radiation is found to be a research tool superior to the conventional methods of soil sterilization (heat, chemicals) in studying certain soil microbiological processes; e.g., in isolating selected groups of microorganisms and in studying their metabolic activities, in exploring the mutual interactions between different groups of microorganisms under field conditions, in studying the enzyme activities without microbial growth, in the reinvasion of sterilized soil by single species of microorganisms and also with the control of soil-borne pathogens. (auth)

38907 STERILIZATION BY GAMMA RADIATION OF A HUMUS IN THE BLACK SPRUCE (PICEA MARIANA). Roberge, M. R. (Ministere des Forets et du Developpement Rural du Canada, Sillery); Knowles, R. Natur. Can., 94: 221-7(1967). (In French).

Samples of different layers of the humus horizon collected in a black spruce (Picea mariana (Mill.) BSP.) stand at Baie-Comeau, P. Q., were irradiated with a ^{60}Co source. The number of viable bacteria and fungi in the humus and their multiplication, after application of different doses, were evaluated by means of a dilution plate technique. Under the conditions used, a dose of 1,110 krad may be considered as the sterilizing dose for black spruce humus. Results show that with this dose more than 80% of the samples were free of microorganisms, and more than 95% free of microorganisms able to multiply in the humus. (auth) (Canada)

38908 FOOD IRRADIATION: A THREAT TO DEEP FREEZING PROCESSES. Masefield, J. (Masefield Irradiation Consultants Ltd., Montreal). Eng. J. (Montreal), 52: 7-10(May 1969).

There are still a number of technical difficulties to be overcome before food irradiation becomes commercially feasible. Of these, the most significant is that of proving conclusively that irradiated foods in general are completely safe for consumption. A lesser problem is that of controlling off-odors and flavors induced by the formation of volatile compounds at high dose levels. The cost of irradiating food ranges from 1/20¢/lb to 5¢/lb, depending upon the application and total absorbed dose. These costs appear to be justifiable in light of the potential savings in spoilage losses, distribution costs, and in added product value. It would appear that there will be some commercial production of irradiated foods within the next five years which could include the radiation sprout inhibition of potatoes and onions, the radio-pasteurization of selected fresh fruits, fish, and meats to extend their refrigerated shelf life, and the radiation sterilization of prepackaged meats to render them shelf stable at room temperature. In North America and Europe, however, it could be two decades before food irradiation experiences wide scale commercialization and takes its place among other competitive food processing techniques. In some of the developing countries, on the other hand, where the need for food preservation is more pressing, commercialization could be achieved much sooner. Food irradiation does not at this time represent a threat to refrigeration. When and if wide scale commercialization is achieved, it could compete with certain frozen items such as fish or meat. At some intermediate stage when commercialization is starting to get underway, say in three to five years, the question "Is irradiation a threat to refrigeration?" should be reviewed again. (auth) (Canada)

38909 STATUS OF THE FOOD IRRADIATION PROGRAM. HEARINGS BEFORE THE SUBCOMMITTEE ON RESEARCH, DEVELOPMENT, AND RADIATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETIETH CONGRESS, SECOND SESSION, JULY 18 AND 30, 1968. Washington, D. C., Joint Committee on Atomic Energy, 1968. 745p. GPO $3.00.

Hearings were held on July 18 and July 30, 1968 before the Subcommittee on Research, Development, and Radiation of the Joint Committees on Atomic Energy on the status of the food irradiation program. The status of the AEC low-dose radiation food pasteurization program, the Department of the Army high-dose radiation sterilization program, and petitions submitted to the Food and Drug Administration (FDA) for approval of radiation processed foods for human consumption are reviewed. It is pointed out that prior to 1968 only irradiated potatoes and wheat were approved for human consumption in the USA and that no new foods were approved between 1966 and 1968. Petitions for the release of irradiated citrus fruits, strawberries, and canned smoked hams were withdrawn. It was pointed out that the FDA was considering rescinding the release of radiation processed bacon. A petition jointly submitted by the AEC and the Department of the Army for the release of radiation processed cod fish, supported by wholesomeness data developed during 2-year animal feeding studies, was being held in abeyance by the FDA. The AEC protocal for long-term animal feeding studies to determine the wholesomeness of radiation processed foods is presented. Statements by personnel of the AEC, the Department of the Army, the FDA, expert witnesses, and other interested persons regarding food irradiation programs in the USA and foreign countries are included. Data are presented on the wholesomeness of radiation processed bacon, ham, soft-shelled clams, fish, peaches, and tropical fruits such as bananas, mangoes, and papayas. Packaging and commercial transportation of radiation processed foods are discussed. Public Law 85-929 (1958), governing FDA regulation of the release of irradiated foods for human consumption, is appended. A report by a joint committee of the United Nations Food and Agriculture Committee, International Atomic Energy Association, and world Health Organization concerning the technical basis for legislation on irradiated food; summary reports presented at the Seventh Annual AEC Food Irradiation Contractors meeting (1967); and a summary of Food Irradiation Progress Outside the United States are included. (C.H.)

38910 LOW-DOSE GAMMA-IRRADIATION TECHNIQUE FOR EXTENSION OF STORAGE LIFE OF SEED POTATOES. Mathur, P. B. (Central Food Technological Research Inst., Mysore, India). Int. J. Appl. Radiat. Isotop., 20: 298-300 (Apr. 1969).

It has been shown that treatment of gamma-irradiated table potatoes with methyl ester of indolyl-3-acetic acid results in a reduction in the percentage of decay, in cumulative physiological losses in weight, as well as the extent of sprouting during storage. The gamma-ray dose employed in the above-mentioned investigation was the minimum dose for irreversible prevention of sprouting of the potatoes, viz., 10 krad. It seemed that if the maximum gamma-ray dose for reversible inhibition of sprouting of seed potatoes could be combined with a treatment with methyl ester of indolyl-3-acetic acid, the storage life of such seed potatoes would be considerably increased. Such a study is described. It was also considered desirable to find out the best developmental stage for gamma irradiation of seed potatoes. The maximum extension of storage life was obtained with potatoes that were irradiated at the respiratory pre-dormancy minimum stage, and treated with the methyl ester soon after irradiation. (auth) (UK)

38911 MICROBIOLOGICAL CONTROL OF RADIATION STERILIZATION OF MEDICAL SUPPLIES. I. THE TOTAL COUNT ON MEDICAL PRODUCTS (DISPOSABLE SYRINGES AND DONOR SETS) PRIOR TO RADIATION STERILIZATION. Christensen, Ebbe Ahrensburg; Mukherji, S.; Holm, Niels W. (Danish Atomic Energy Commission, Risoe). Arch. Pharm. Chem., 75: 941-57(1968). (In Danish). (RISO-122).

A technique for determination of the number of microorganisms on dry disposable equipment prior to radiosterilization is described. A total of 1678 hypodermic syringes from the same producer has been investigated. The average counts for the period of investigation was calculated to be in the range of 3.5 to 10.8 per syringe. Only 9 syringes, i.e., 0.54% of the samples, gave off more than 100 organisms per syringe. The highest single count was 294 (obtained from a 20 cc syringe). A total of 297 donor sets from another producer was investigated. The average counts from the individual batches varied between 0.3 and 61 organisms per

sample. The highest single counts were 800 and 840. The relations applied at Risø between initial counts as determined from the products, and the minimum doses used for radiosterilization are described. Products as the syringes referred to above were irradiated with a minimum dose of 3.5 megarad. Equipment for blood banks, as the donor sets, has been negotiated with the Danish Health Authorities. (Denmark)

38912 EFFECT OF GAMMA RADIATION ON THE TSETSE FLY GLOSSINA MORSITANS WESTW. Dean, G. J.; Wortham, S. M. (University Coll. of Rhodesia, Salisbury). Bull. Entomol. Res., 58: 505-19(Feb. 1969).

Pupae of Glossina morsitans or emerging adults were exposed to ^{60}Co γ radiation at dose rates between 54 and 122 rad/min. Mortality in the pupal stage increased from 23% at 2000 rad to 64% at 15,000 rad. Pupae deposited in spring (August–October) were more sensitive to γ rays than those collected in winter (May–July). Irradiation reduced reproduction by over 95% between 8000 and 15,000 rad for males emerging within the first 2 wks after treatment; while males emerging during the third post-treatment week were completely sterilized with doses above 4000 rad. Treatments given as fractions 1 and 4 days apart gave a slightly higher level of residual fertility than that obtained with similar but continuous total doses. Irradiation of adult males reduced reproduction to an extent comparable with that observed in males emerging from pupae within 2 wks of treatment (>90% from 8000 rad). Females treated either as adults or as pupae were completely sterilized with 1000 to 8000 rad. Males exposed to 8000 and 12,000 rad retained their sterility throughout 39- and 45-day test periods, and were fully competitive with untreated males. Survival of virgin flies emerging from treated pupae was reduced both by increasing doses from 4000 to 15,000 rad and decreasing pupal age at the time of treatment. Mortality during the 28-day mating period decreased with 1000 and 2000 rad, increased up to 8000 rad, and apparently decreased with 12,000 and 15,000 rad. When the doses were fractionated, survival was longer than when treatment was continuous, and mortality was reduced to the level expected from the size of the first fraction. Virgin adult males given doses between 4000 and 18,000 rad and females given 2000 and 4000 rad lived longer than the corresponding controls. The ability of males to inseminate females was not affected by any doses used, and sperm from irradiated males were mobile and apparently behaved normally. Dominant lethality in the males was expressed by the failure to produce pupae in matings with untreated females, and in the treated female fly by the complete failure of oogenesis. (BBB)

38913 A STUDY OF THE FACTORS INFLUENCING STERILIZATION BY HEAT AND RADIATION. Wilson, D. A. (Abbott Labs. Ltd., Queenborough, Eng.). J. Med. Lab. Technol., 25: 301-12(Oct. 1968).

Different methods of sterilization are described and the factors influencing the destruction of microorganisms by heat and ionizing and nonionizing radiation are presented. Ionizing radiations are highly lethal and their use requires extreme care. Treatment with high-energy radiations produces injury of vital cells components, including DNA. Also the internal membranes of the cell may be ruptured and this leads to disorganization of the cell enzymes. Microorganisms continue their normal metabolic processes (e.g., respiration, motility) for many hours after irradiation. For this reason the term inactivation is preferred to cell death. Vegetative microorganisms require a dose of 0.05 to 0.5 Mrad for sterilization. However, a nonpathogenic microorganism, Micrococcus radiodurans, is reported as requiring 5 to 6 Mrad for sterilization. Spores have a higher resistance to radiation than vegetative microorganisms. A dose of 1.0 Mrad should sterilize a medium containing 10,000 Bacillus subtilis spores/ml, the last single spore having but one chance in a million of surviving. Bacillus pumilus is considered as being the most suitable microorganism for checking the effectiveness of radiosterilization. Radiosterilization may be applied to disposable surgical materials and pharmaceutical products. Ultraviolet rays in the range of 2100 to 2960 Å are also extremely lethal to microorganisms. At these wavelengths, the uv rays produce changes in the DNA of the cell. Gram-positive microorganisms have a slightly greater resistance to uv radiation than Gram-negative microorganisms. The optimum lethal wavelength for staphylococci is 2652 Å. Spores are more resistant to uv radiation than vegetative microorganisms. Ultraviolet radiation within the wavelengths 2652 and 2804 Å can be used to kill spores. Filterable viruses are extremely resistant to uv light. (BBB)

38914 PROGRESS OF FOOD IRRADIATION WORK. Food Irradiat., 9: No. 3, 2-37(Jan.-Mar. 1969).

A survey of the research work undertaken in 1968 by member countries of the Organization for Economic Cooperation and Development (OECD) is presented. Projects briefly summarized that were continued or initiated during the research year were in the areas of radiation processing of cereals (barley, rice, wheat, and wheat flour), dairy products (eggs and fresh and dried milk), fruits and fruit juices (apples, blueberries, cranberries, oranges, peaches, raspberries, and strawberries), meats (beef, fish, pork, poultry, and seafood), vegetables (corn, cucumbers, eggplant, lettuce, mushrooms, peas, potatoes, pumpkins, sugar beets, and tomatoes), coffee beans, olive oil, and poultry feed. The regulations and petitions on Radiation Preservation of Foods and Packaging Materials prepared in January, 1969, which contains a list of all formal actions taken before the U. S. Food and Drug Administration is included. The material is arranged by country with sections under each on applications in pilot plants, dosimetry, future program, irradiation facilities, legislation, research, and wholesomeness. A group of tables and a bibliography are included. (C.O.)

38915 PROCESS CRITERIA FOR PRODUCING RADIATION STERILIZED FISH PRODUCTS. Learson, R. J. (Bureau of Commercial Fisheries Technological Lab., Gloucester, Mass.); Ronsivalli, L. J.; Spracklin, B. W.; Heiligman, F. Food Technol., 23: 1071-7(Aug. 1969).

Research was aimed at developing a suitable technique for producing radiosterilized fishery products from fish fillets. Holding the products at low temperatures during γ irradiation and using various additives reduced adverse radioinduced changes in flavors and odors. Controlled enzyme inactivation procedures and use of a suitable edible coating effectively stabilized the physical structure of the products. By these means, radiosterilized fish fillets were produced that were highly acceptable immediately after being irradiated. Subsequent room temperature storage of the treated samples, however, resulted in marked discoloration of the fillets (browning). The heat treatment given to the products for enzyme inactivation prior to radiosterilization was found to have the greatest effect on the development of browning. Research indicated that the browning reaction is nonenzymatic although the availability of reactants may be the result of enzymatic activity. Apparently, unless a solution to the browning problem can be found, the production of an acceptable radiation sterilized fish item prepared from a fillet or a steak is unlikely. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 38068, 38073, 38137, 38144, 38228, and 39015.

38916 (AHSB(S)R-167) RECOMMENDATIONS ON THE SAFE HANDLING OF ZIRCONIUM METAL AND ZIRCONIUM ALLOYS. Bulmer, G. H. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). 1969. 51p. (AHSB(S)R-59(Rev.)). Dep. CFSTI. UK 8s.

Revised recommendations on the safe handling of zirconium metal and zirconium alloys are presented. Following a summary of the physical, chemical and toxic properties of zirconium, the design features necessary to ensure an adequate safety standard in the construction and installation of plant in process areas, and in laboratories and stores are given. Where appropriate statutory and non-statutory regulations are quoted and used as a framework for specifying operational safety requirements for both normal and accident conditions. Special conditions applicable to the storage and disposal of unirradiated and irradiated zirconium are given in respect of the several forms of waste likely to be met with, and recommendations are made on transport and containers. (auth) (UK)

38917 (BNWL-1058) REACTOR FUELS AND MATERIALS DEVELOPMENT PROGRAMS FOR FUELS AND MATERIALS BRANCH OF USAEC DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY. Quarterly Progress Report, January-March 1969. Bement, A. L.; Dau, G. J.; Evans, E. A.; Nightingale, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1969. Contract AT(45-1)-1830. 260p. Dep. CFSTI.

Information on fuels and materials research progress is presented in eight sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 38135, 38208, 39007-39009, and 39063-39065.

38918 (NLCO-1037) LOT CONTROL IN THE PRODUCTION OF URANIUM FUEL CORES. McCreery, P. N. (National Lead Co. of Ohio, Cincinnati). Feb. 17, 1969. Contract AT(30-1)-1156. 8p. (CONF-690524-1). Dep. CFSTI.

From 23rd Annual Technical Conference of the American Society for Quality Control, Los Angeles, Calif.

Development of a quality assurance program from an inspection-oriented procedure to a control-oriented records system compatible with EDP is described. Punch cards are used to code each plant operation from U refining to machining of U rods into cores. The system is so arranged that with the aid of an intercom to each station, each step can be certified. (J.R.D.)

38919 (UCRL-50622) STATISTICAL NATURE OF FRACTURE. Robinson, Ernest Y. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 30, 1969. 37p. Dep. CFSTI.

Methods for statistical analysis of strength and fracture of materials are examined. The weakest link model is considered in a fairly general form, and the resulting equations are demonstrated by using a Weibull distribution for flaws. Since this is one of the asymptotic extreme value distributions it appears naturally in a variety of problems, and therefore additional attention is devoted to analysis and statistical estimation connected with this distribution. Working charts are included to facilitate interpretation of observed data. Nominally ductile materials often show extreme variability in fracture toughness measurements. Estimates of the operational capability of a part made from such a material must account for the variation of flaw intensities (a statistical variable dependent on geometry and fabrication), the variation of fracture toughness (a statistical variable dependent on material properties), and the quantity and density of flaws in the part. Examples are cited which indicate that the most intense flaw is likely to be found in association with the weakest material in terms of fracture toughness, thus corroborating the need for a statistical approach to failure prediction. Idealized failure in a system comprising parallel brittle elements is described. Graphs are included for predicting the failure of such a system. (auth)

38920 LE FLUAGE. 11e Colloque de Metallurgie, Saclay, 22-23 Juin 1967. (Creep. 11th Symposium on Metallurgy, Saclay, France, June 22-23, 1967). Colloques de Metallurgie Speciale Precedemment Publies. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1968. 185p. (CONF-670664).

Nineteen papers were presented at the conference. A separate abstract was prepared for each of seven papers. Papers for which no abstracts were prepared are concerned with structural modifications, creep of glasses, role of grain boundaries, creep of Al, creep of Mg alloys, low-temperature creep, relaxation in steels, slip in Fe, microfractography, high-temperature creep, and creep of steels. (J.R.D.)

For abstracts of individual papers see: 38961-38966 and 39010.

38921 MECHANICAL BEHAVIOR OF MATERIALS UNDER DYNAMIC LOADS. Symposium Held in San Antonio, Texas, September 6-8, 1967. Lindholm, Ulric S. (ed.). New York, Springer-Verlag New York Inc., 1968. 434p. (CONF-670986).

A total of nineteen papers were presented at the conference. An abstract was prepared for one paper. The papers for which no abstracts were prepared are concerned with ideal solids, plastic waves in long rods, viscoplasticity, plane strain cracks, dislocation dynamics, equations for materials dynamics, impact, wave propagation, dynamic plasticity, and mechanical properties of rocks. (J.R.D.)

For an abstract of the individual paper see: 38990.

38922 PHENOMENOLOGICAL STUDY OF CREEP. Crussard, C. (Compagnie Pechiney, Paris). Mem. Sci. Rev. Met., 66: 333-46(May 1969). (In French).

Creep is a complex phenomenon, which involves a number of correlated effects, but it can be explained by models or typical phenomena for each of the investigated groups of phenomena. (auth)

Corrosion and Erosion

Refer also to abstract 38947.

38923 (AI-AEC-12833) SODIUM CHEMISTRY LOOP FACILITY DESCRIPTION. Guon, J.; Vislay, H. A. (Atomics International, Canoga Park, Calif.). June 30, 1969. Contract AT(04-3)-701. 52p. Dep. CFSTI.

An experimental facility, the Sodium Chemistry Loop (SCL), was constructed to study the equilibrium between sodium oxide and metal oxides in sodium systems. Operational data indicate the SCL meets or exceeds specifications. Although new data on the oxygen probe have been developed, the probe's performance is not yet understood well enough to evaluate its effectiveness in developing kinetic data for the sodium-oxygen-metal systems to be studied. (auth)

38924 (TRG-Report-1835) THE COMPATIBILITY OF NIMONIC ALLOYS WITH MIXED (U,Pu) CARBIDES. Batey, W.; Donaldson, D. M.; Irons, H. W.; Yates, G. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). Mar. 24, 1968. 17p.

Compatibility tests between mixed (U,15% Pu) carbides of varying carbon content and the Nimonic alloys 80A and PE16 have been carried out in the temperature range 650 to 800°C for periods of up to one year. Carburization of the Nimonics was observed to occur at the low end of the temperature range but at a low level. Reaction involving pit formation in the Nimonics, however, occurred to some extent in all the tests with one exception, that comprising Nimonic PE16 at 650°C when only carbon transfer was observed. The reaction appears to be independent of carbide composition within a relatively wide range and the depth of penetration of the reaction zone and concomitant pits at 800°C suggests an operational limit of about 750°C at the Nimonic/carbide interface in any fuel pin. (auth)

38925 (WAPD-Trans-119) ZIRCONIUM AS MATERIAL FOR THE REACTOR CORE. Roesler, Ulrich; Rubel, Hartmut. Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from Siemens-Z., 42: 44-50(1968). 21p. Dep. CFSTI.

A review of the development and properties of Zr and its alloys for reactor uses is presented. Included are discussions of Zr alloy uses in water-cooled reactors, corrosion and water sorption, mechanical properties, and diffusion of oxygen in the metal. (J.R.D.)

38926 THE EFFECT OF COLD-WORK ON THE OXIDATION OF Zr-1 PERCENT Nb ALLOY IN AIR AND PRESSURIZED STEAM AT 450 TO 550°C. El-Shanshoury, I. A.; Rudenko,

V. A.; El-Dahshan, M. E. (Atomic Energy Establishment, Cairo). Corros. Sci., 9: 479-88(July 1969).

The corrosion behaviour of annealed and cold rolled Zr–1% Nb alloy (2, 4, 8 and 10% reduction in thickness) was investigated in air and pressurized steam at 450, 500 and 550°C. The corrosion resistance of the cold rolled specimens was found to be higher than that of the annealed specimens and increased with increase in the degree of cold-work. The activation energies were calculated to be 38.5 and 25.3 kcal/mole for air and steam, respectively, and were independent of the degree of cold-work; the only variable is the constant of the Arrhenius equation. Electron microscope investigation showed that the oxide film of the annealed specimens is not uniform and varies from one grain to another. Deformed specimens showed uniform thickness with a random orientation of the crystallites. The increase in corrosion resistance with increase of the degree of cold work is explained on the basis that cold work lowers the degree of misfit between contiguous grains, with reorientation of the crystal lattice in such a way that the c-axis tends to be parallel to the surface of the specimen, with a consequent decrease in the rate of diffusion of oxygen. (auth) (UK)

38927 THE EFFECT OF AN EXTERNAL ELECTRICAL FIELD ON THE OXIDATION RATE OF U. Leach, J. S. Ll.; Nehru, A. Y. (Univ. of Nottingham, Eng.). Corros. Sci., 9: 447-53(July 1969).

The effect of an external electrical field on the oxidation of U was studied using an optical technique for the measurement of rate. It was shown that fields as small as ~100V/cm can influence the oxidation provided water dipoles are present in the reacting atmosphere. (auth) (UK)

38928 IMPROVEMENTS IN PICKLING APPARATUS. Edwards, Derrick Robert (to United Kingdom Atomic Energy Authority). British Patent 1,157,645. July 9, 1969. Filed Nov. 19, 1965.

Reference is made to apparatus for performing pickling processes in which metal objects are treated with an etching liquid, so that the outer surface layer is removed by chemical action to leave a clean free surface. The usual pickling plants possess disadvantages which allow only inadequate control over the pickling operation, due mainly to slow transfer between the etching and "stop" sections, and inadequate mixing of the etching liquid; they often also require elaborate safety schemes to protect operating personnel from toxic and splash hazards, and may employ complex mechanical linkages liable to corrosion. The apparatus described comprises a pickling vessel, storage tanks for treatment liquids, means for filling the pickling vessel from any one storage tank, and means for causing oscillatory turbulent flow of liquid in the pickling vessel, while maintaining the vessel full of liquid. The pickling vessel may be in the form of a vertical tube with means for connecting a storage tank to its lower end and a surge tank to its upper end. Gas under pressure is admitted to the storage tanks and the surge tank to produce oscillatory turbulent flow of liquid. The pickling vessel may be self-draining into the storage tanks. An example is given of use of the apparatus for the "cleaning" of Zr-canned reactor fuel elements, after manufacture, using HF/HNO_3 as etching liquid. (UK)

38929 CORROSION AND COMPATIBILITY OF VANADIUM ALLOYS FOR FUEL ELEMENT CLADDING. Thomas, K. C.; Bishop, E. C.; Whitlow, G. A. (Westinghouse Electric Corp., Madison, Pa.). Nucl. Appl., 7: 144-54(Aug. 1969).

Vanadium alloys have been identified as one of the leading alternate cladding materials for liquid-metal-cooled fast breeder reactors for circumventing the possible limitations of austenitic stainless steels. Two of the more important aspects of this usage on which little information is available are sodium corrosion and compatibility with ceramic fuels. A series of experimental vanadium alloy compositions were found to increase in weight and in hardness after 500 hr exposure to flowing sodium containing ~10 ppM oxygen at ~790°C; these changes are due to the absorption of oxygen, carbon, and nitrogen. In 1000-hr tests at 800°C, some incompatibility was observed only between vanadium alloys containing iron and uranium-carbide fuel. The screening tests were used to identify Vanstar-7, -8, and -9 as worthwhile alloys for further study. (auth)

38930 OXIDATION OF 0.4 WT PERCENT Ca–Be ALLOY IN MOIST CO_2. Kondo, Yasuko; Nagasaki, Ryukichi; Sano, Tadao (Japan Insulation Co., Nagoya). Nippon Kinzoku Gakkaishi, 33: 750-4(1969). (In Japanese).

A 0.4 wt % Ca–Be alloy was oxidized in moist CO_2 (water vapor pressure, 14 to 25 mmHg) over the temperature range 700 to 800°C. Discontinuity of the weight gain vs. time curves suggests that the oxidation of 0.4 wt % Ca–Be alloy occurs through three reaction stages. The rates of oxidation at the initial two reaction stages were parabolic. The effect of water vapor pressure on the parabolic rate constants as $k_p = k_p^0 \exp\{a.P_{(H_2O)}\} \exp(-\Delta H/RT)$, where k_p is the parabolic rate constant, k_p^0 the parabolic rate constant in dry CO_2, a constant, ΔH the activation energy for the parabolic oxidation. Pressure of moisture effected the activation energy of the reaction suggesting that the rate controlling step is different from that for dry CO_2. Increase in the partial pressure of water vapor causes a change in the entropy term in a manner indicated in the equation. The third stage follows a linear rate law resulting in a rapid disintegration. (auth)

38931 CORROSION OF COBALT AND COBALT ALLOYS. Morral, F. R. (Battelle Memorial Inst., Columbus, Ohio). Corrosion, 25: 307-22(July 1969).

Investigations are reviewed of the composition and structures of corrosion films and scales found on cobalt and on simple and complex cobalt-base industrial alloys. The corrosion resistance of these films and scales depends on metal and alloy composition, environment (an atmosphere containing one or more of CO_2, S, H_2S, O_2, H_2O, SO_2, V_2O_5, NaCl, and pressure, temperature, and time. Additional factors, alone or in combination, such as surface preparation, stress, thermal shock, geometry of the part, velocity, density, and flow pattern of the corroding environment also have an effect. Data on oxidation, sulfidation, and hot corrosion (a combination of the first two) of cobalt and its alloys are summarized in some detail, as are the known characteristics of the films and scales that are formed. Only the work that used techniques permitting determination of composition and crystal structure of these films and scales was reviewed. The effect of impurities in metals and alloys may be as significant as that of added alloying elements; impurities may alter the scales' chemical and physical properties–increasing, decreasing, or neutralizing corrosion rates. Until data are available on the intereffect on diffusion of elements present in scales, films, and metal surfaces, the mechanisms of corrosion proposed are only hypotheses. (auth)

38932 CONTAINMENT MATERIALS FOR PYROCHEMICAL PROCESSES. Kyle, M. L.; Pierce, R. D.; Kolba, V. M. (Argonne National Lab., Ill.). Nucl. Met., Met. Soc. AIME, 15: 433-52(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Studies are being made of the corrosion resistance of potential containment materials to pyrochemical process solvents. Solvents of interest are alloys of copper, cadmium, zinc, and magnesium as well as salts of alkali and alkaline earth halides at system temperatures from 500 to 900°C. The materials selection considerations and typical corrosion results are presented for broad classes of materials such as ferrous alloys, refractory metals, graphite, and ceramics. Refractory metals are generally preferred because of their low corrosion rates and their inertness to process solutes. (auth)

38933 CORROSION OF A LOW ALLOY STEEL IN A SIMULATED LIQUID-METAL-FUEL REACTOR MIXTURE. Suchanek, Roger L.; Burnet, George (Ames Lab., Iowa). Nucl. Met., Met. Soc. AIME, 15: 453-66(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

An isothermal dynamic testing technique was used to investigate the corrosion of 2¼% chromium–1% molybdenum alloy steel first by pure liquid lead–bismuth eutectic (55.5% Bi) and then by zirconium-inhibited eutectic to which elements were added to simulate those fission products found in a liquid-metal-fueled reactor. When exposed to the eutectic alone the steel was found to be highly resistant to attack up to temperatures of about 700°C. Above 700°C the degree of attack increased with temperature until at 900°C only long fingers of ferrite remained at the metal surface in place of the original material. In tests with the simulated reactor mixture inhibited with zirconium, the temperature was raised to about 800°C before corrosion was detected. The mixture consisted of the eutectic plus Zr, U, Mg, Mo, Ce, Nd, and La as additives. Above 800°C the same increase in attack with temperature as occurred with the pure eutectic was observed. (auth)

38934 CORROSION OF THE ALLOYS Fe–Cr, Ni–Cr, AND Co–Cr AT HIGH TEMPERATURE. Davin, A.; Coutsouradis, D.; Habraken, L. (Univ., Liege). Ind. Chim. Belge, 32: Special No., (Vol. 1), 446-50(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

In the field of refractory alloys, it appears more and more that resistance to oxidation at high temperature is of considerable importance. The kinetics of corrosion at high temperature have been studied for different alloys of Fe–Cr, Ni–Cr, and Co–Cr. The ef-

fects of various elements, such as Nb, Ta, Mo, W, Zr, Y, Ni, Fe, Al, B, Tl, and Ce, on the resistance to oxidation, to sulfurization, and to gaseous products of combustion from light fuel added to control amounts of sulfur and other impurities were determined for Co–Cr alloys. Corrosion phenomena at high temperature are complex. The reactions, in most cases, are governed by the diffusion of metallic cations toward the oxide or sulfide interface with the gas. The results indicate that, independently of protective coatings, it is possible to control the kinetics of corrosion of these base alloys by the use of additional elements chosen judiciously. (tr-auth)

Preparation and Fabrication

Refer also to abstract 38967.

38935 (BNL–13829) CONTROL OF SURFACE CONTOUR AND SMOOTHNESS ON IRON ELECTRON-TRANSMISSION SPECIMENS. Bryner, Joseph S. (Brookhaven National Lab., Upton, N. Y.). [nd]. 20p. Dep. CFSTI.

A method is described for reliable production of abundant, smooth, strain-free electron-transparent metal in iron specimens up to 0.3 mm thick in a single operation at ambient temperature. Smoothness is controlled by the electrolytic potential and the modified composition of the chromic-acetic acid electrolyte. Surface contour is controlled by adjusting the spacing between the specimen and the cathodes and revolving both specimen and cathodes in a circular orbit parallel to the specimen faces. Limiting the electrolytic current to exposed areas on the specimen faces through use of an anodized tantalum specimen holder obviates the necessity for cooling and permits detection of a self-indicating end point. The method yields satisfactory results on iron-, nickel-, and cobalt-base alloys. (auth)

38936 (HW–71380) END CLOSURE OF NPR FUEL TUBES. Progress Report. Correy, Thomas B. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Nov. 18, 1961. Contract AT(45-1)-1350. 56p. Dep. CFSTI.

Development of a diffusion bonded end closure for the NPR fuel tubes is described. The bond has been developed at 600 to 650°C, for time ranges of six hours to one minute at temperature and 10,000 psi. Cathodic etching in argon of the surfaces to be bonded has permitted bonding with these parameters. The uranium-to-Zircaloy-2 bond has been developed to the point that it is readily reproducible and of adequate strength. The bond between Zircaloy-2 and Zircaloy-2 is not adequate. Methods under investigation to improve the bond are described in this document. Some test fuel tube sections have been assembled satisfactorily by this process. (auth)

38937 (HW–72376) ALTERNATE END CLOSURE FOR NEW PRODUCTION REACTOR FUEL ELEMENTS. Correy, Thomas B. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Jan. 19, 1962. Contract AT(45-1)-1350. 40p. Dep. CFSTI.

A diffusion bonded end closure for the New Production Reactor fuel elements is described. The basic criteria for the closure include closure temperature below 650°C, the alpha-beta transformation temperature of uranium, complete diffusion bonds between the Zircaloy-2 closure ring and the uranium core and Zircaloy-2 cladding, and external fusion weld of the Zircaloy-2 closure ring to the Zircaloy-2 cladding to provide a two-process closure. The components are maintained in an inert atmosphere or vacuum from the start of cathodic etching until completion of the closure ring to cladding welds. The surfaces to be bonded are cathodically etched to remove oxide and other films. Clean, pure, gas-free, copper is added to the cathodically etched cylindrical surfaces of the Zircaloy-2 closure ring to promote bonding to the Zircaloy-2 cladding and eliminate the void at the cap-core-clad juncture. The closure ring is welded to the cladding with an electron beam to minimize the residual gas in the bond. The fuel tubes are subjected to gas pressure autoclave bonding at 650°C for one hour at 10,000 psi. (auth)

38938 (SRO–475-2) THE EFFECT OF DIE ROTATION ON THE COMPACTION OF METAL POWDERS. Progress Report. Schwartz, E. G.; Hammond, L. F. (South Carolina Univ., Columbia. Coll. of Engineering). 1969. Contract AT(38-1)-475. 41p. Dep. CFSTI.

Thesis. Submitted by L. F. Hammond, Jr.

An analysis of die wall rotation during the compaction of aluminum 101 powder into annular compacts has been made. The analysis is begun with a review of current literature concerning stress measurements and lubrication during the pressing process. One previous account of die rotation is also recognized and discussed. By considering the equilibrium of an element of powder it is shown that the axial stress within the compact follows an exponential decay. By assuming that radial stress, σ_r, is related to the axial stress, σ_a, by a constant, k, and also the the shear stress, τ, is related to the radial stress, σ_r, by the coefficient of friction μ, it is shown that the radial stress σ_r and shear stress τ_{ry} also follow an exponential decay. The constants k and μ are evaluated by assuming that a shear stress exists at the compact-die interface greater than the shear strength of aluminum. A comparison is presented of the measured loads on a compact for static compactions and then for rotation. The experimental graphs of primary interest are die wall friction versus applied axial stress and the transmitted stress versus the applied axial stress. The prime conclusion drawn is that die wall rotation during the pressing of metal powders can substantially reduce die wall friction. (auth)

38939 PROCESS FOR WELDING TUBES MADE OF COMPOSITE METAL–METAL OXIDE MATERIALS, MORE PARTICULARLY FOR CLOSING CANS OF NUCLEAR REACTOR FUEL ELEMENTS. Klersy, Raymond; Musso, Giuseppe (to EURATOM). British Patent 1,158,458. July 16, 1969. Priority date June 16, 1966, Belgium.

A process is described for extrusion joining of tubular elements made of metal–metal oxide composite materials having the same composition or different compositions without impairing the structure of the dispersion. Metal alloys may be joined to these composites by the same methods. The process is useful in welding plugs in the ends of metal-metal oxide fuel cans. (J.R.D.)

38940 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Ridgway, James (to United Kingdom Atomic Energy Authority). British Patent 1,157,792. July 9, 1969. Filed Dec. 8, 1965.

Reference is made to fuel element assemblies of cluster type, the sheath of each element having metal pads at the locality of the spacing the sheath surfaces from the grids (see also British Patent 1,114,706). In the arrangement described the metal pad has projections to enable projection resistance welding of the pad to the sheath, with a brazing clearance between the pad and the sheath; braze metal in the form of foil is attached to the pad by spot brazing, the pad is attached to the sheath by resistance welding and the braze metal melted so as to effect a brazed joint between the pad surface and the sheath. The sheath and metal pad may be of Zr alloy and the braze metal may be Zr–5% Be. (UK)

38941 FUEL ELEMENTS. Johnson, James R.; Sowman, Harold G. (to Minnesota Mining and Mfg. Co.). U. S. Patent 3,454,396. Filed Sept. 22, 1966.

A process is given for making nuclear fuel elements consisting of a metallic fueled matrix clad with unfueled metal. The metal matrix and cladding are united into an integral structure in which the particulate nuclear fuel is distributed in predetermined location consisting of preparing green films or sheets of metallic powder, particulate nuclear fuel and organic binder. The sheet containing fissionable fuel particles is coated with a cladding film or sheet of metallic powder and organic binder to produce a green, flexible laminate. The green laminate is then compacted slightly under enough pressure to reduce its thickness by no more than 10 percent to firmly adhere the cladding sheets and fueled sheets and to remove any voids. Sinter-welding the metallic particles unifies the green laminate and unifies the layers of the laminate into a single, integral metallic sheet. The fissionable fuel particles are located in an inner zone of the sheet in a predetermined location. (Offic. Gaz.)

38942 CONTROLLED PREPARATION OF ALLOYS BY SIMULTANEOUS, MULTITARGET SPUTTERING. Segatto, Peter R. (Corning Glass Works, N. Y.). J. Vac. Sci. Technol., 6: 368-72(May-June 1969).

The preparation of alloy films by multitarget, triode sputtering is described. An apparatus designed to sputter two or three targets simultaneously onto a rotating substrate holder is described. The sputtering parameters necessary to vary and reproduce alloy composition are discussed. Changes in alloy composition are obtained by voltage variation of the several targets. Reproducible film compositions are assured by maintaining target voltage, geometry, and sputtering atmosphere constant. Zero or a constant partial pressure of hydrogen is required to obtain reproducible alloy properties. Composition, resistance, and thickness data are presented for the alloy systems Nb–Zr and Nb–Zr–Mo. Sheet resistance values for these films are reproducible to ±2%. (auth)

38943 FORMATION OF AN [INTERMEDIATE] LAYER IN THE VACUUM DEPOSITION OF REFRACTORY MATERIALS. Nikiforov, G. D.; Privezentsev, V. I. Fiz. Khim. Obrab. Mater., No. 1, 86-94(Jan.-Feb. 1969). (In Russian).

The mechanism responsible for the binding of refractory-metal (W,Mo) particles to the substrate on vacuum deposition by the plasma technique is discussed and measures that may be taken to improve the contact forces and general quality of the deposited material are considered. The adhesive strength of such coatings is largely determined by the period for which the zone of contact remains at a temperature favorable towards bond formation and also the thickness of the oxide coating on the surface. Pores and oxide coatings may seriously reduce the quality of the final material. The properties may be improved by sintering in H or vacuum. In the case of W the application of Cu also produces favorable results. (Metals Abstr.)

38944 PROCESS FOR COATING NUCLEAR FUEL PARTICLES. (to EURATOM). French Patent 1,444,682. Filed Oct. 1, 1964.

A process is described for coating nuclear fuel Kernels with at least two layers of a substance which delays the emission of fission products. The process comprises charging the Kernels into a fluidized bed apparatus, fluidizing the Kernels by means of an inert gas, e.g., Ar, contacting them with a carbon-containing gas, e.g., methane, at a temperature such that pyrolytic carbon is deposited on to the Kernels, e.g., 1600°C, interrupting the deposition process, cooling the coated Kernels and exposing them to the air, and then applying at least one more coating of pyrolytic carbon. In a modification the second layer consists of silicon carbide deposited from methyltrichlorosilane vapor in the presence of hydrogen. (NPO)

38945 COATING NUCLEAR FUEL PARTICLES WITH PYROLYTIC CARBON. (to NUKEM Nuclear-Chemie und -Metallurgie GmbH). French Patent 1,478,731. Filed Apr. 26, 1966.

A process is described for coating nuclear fuel particles with pyrolytic carbon in a fluidized bed at high temperatures. The coating is carried out under a total pressure of preferably 20 to 350 mm Hg and a partial pressure of hydrocarbon, e.g., methane, propane, acetylene, of preferably 10 to 350 mm Hg. The fluidizing is effected by the hydrocarbon gas containing none or only a minute quantity of Ar. (NPO)

38946 REMOTE REFABRICATION OF EBR-II FUELS. Feldman, M. J.; Grant, N. R.; Bacca, J. P.; Eschen, V. G.; Mitchell, D. L.; Strain, R. V. (Argonne National Lab., Idaho Falls, Idaho). Nucl. Met., Met. Soc. AIME, 15: 77-96(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

The melt-refining process used for purifying highly irradiated EBR-II metallic fuel does not remove all of the fission products, hence refabrication of the product fuel must be done remotely. The steps involved in refabrication of fuel elements and subassemblies are: injection casting, pin processing (shearing and inspection), loading into a sodium-filled jacket, welding the jacket closed and leak testing, bonding the sodium in the jacket, and assembling the completed elements into a subassembly. The subassemblies are reinserted into the reactor. Nearly 35,000 fuel pins and elements were fabricated by totally remote processing to tolerances of one mil or less. Process variables and yields for each step of the process were investigated. (auth)

38947 USE OF CERTAIN REFRACTORY METALS IN THE METALLURGY OF THE RARE EARTHS. Gaume, F. Ind. Chim. Belge, 32: Special No., (Vol. 2), 189-91(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.2).

The following are described: the fusion of small ingots of rare earth metals such as lanthanum and cerium in pure tungsten or pure rhenium crucibles; the study of the corrosion of these metals as a function of the temperature of contact with the melted ingot and as a function of their surface condition; and the conditions for the use of these refractories in the production of rare earth metals of high purity. (tr-auth)

38948 THE EFFECT OF FIBER ORIENTATION ON THE FATIGUE PERFORMANCE OF FIBER REINFORCED COMPOSITE MATERIALS. Goodwin, Vernon Leon Jr. Raleigh, N. C., North Carolina State Univ., 1968. 75p.

Thesis.

The performance of metal matrix-metal fiber composite systems under conditions of fatigue loading have been both analytically and experimentally investigated. Principal goals were (1) establishment of the influence on fatigue strength of the angle between the axis of loading and the reinforcing filament axis, and (2) determination of fracture modes as a function of filament orientation angle. All composite materials used for these tests were fabricated by reinforcing hot-pressed titanium 6Al-4V or Hastelloy X matrices with 10 mil tungsten or molybdenum wires. The titanium matrix specimens employed 22 per cent by volume molybdenum wires while the Hastelloy X matrix specimens employed 35 per cent by volume of either tungsten or molybdenum wires. Filament orientation angles of 0, 10, 45, and 90 degrees with respect to the axis of loading were employed for the titanium matrix specimens while angles of 0, 30, 60, and 90 degrees were tested in Hastelloy X matrix specimens. In all cases the fatigue strength was found to decrease with increasing angularity between the filament orientation axis and the axis of loading. The extent of this strength loss was found to be greatest in those systems employing greatest volume percentage of rigid reinforcing filaments. For example, the fatigue strength (at a life expectancy of 10^6 cycles) decreased from 63,300 psi to 11,600 psi as the filament angle increased from 0 to 90 degrees in the Hastelloy X plus 35 volume per cent tungsten system. A smaller decrease of 28,000 psi to 11,400 psi was observed in the titanium plus 22 volume per cent molybdenum system. An analytical examination of predicted variations in composite fatigue strength with filament angularity has been made and the results were found to correlate with the experimental data. This analytical procedure allows the fatigue strength of these composite materials to be predicted with a typical accuracy of ±5000 psi. For example, the predicted fatigue strength of a 60 degree Hastelloy X plus 35 volume per cent tungsten specimen is 16,198 psi while experimental tests indicate an actual fatigue strength of 15,800 psi. Considerable attention was given to phenomenological study of filament orientation influence on fracture modes. It was found that fatigue crack initiation loci were always in the matrix portions of the composites studied. However, the patterns of crack propagation were largely controlled by the angularity of the reinforcing filaments. There is considerable evidence that enhanced fatigue life can be obtained through beneficial redirection of fatigue cracks by carefully optimizing both the filament placement and the characteristics of the interfacial layer between the matrix and the filaments. Certainly, there is a definite call for additional work in this area as it is perhaps the most promising method for developing higher fatigue strengths in composite materials. (auth)

38949 PREPARATION OF MASSIVE PLUTONIUM METAL DIRECTLY FROM ITS OXIDES. Wade, W. Z.; Wolf, T. (Univ. of California, Livermore). J. Nucl. Sci. Technol. (Tokyo), 6: 402-7(July 1969).

A technique for the rapid production of massive Pu metal directly from its oxides is described. Salient features of this single unit process are as follows: the reduction of plutonium oxides with Ca metal; the extraction, by dissolution, of the calcium oxide reaction product with molten calcium chloride; and a quantitative separation of the two immiscible molten metal phases by the immiscible salt solution. Reduction, separation and massive metal yield efficiencies are in excess of 99.96%. The purity of the metal produced is equal to that of the initial feed material. The batch cycle time is 15 min. The single waste product is far below recovery level and is discardable as a small volume solid waste. (auth)

38950 A METHOD FOR THE PRODUCTION OF SPHERICAL PARTICLES. Bildstein, Hubet; Knotik, Karl; Stolba, Gerhard (to Osterreichische Studiengesellschaft fuer Atomenergie GmbH). British Patent 1,160,721. Aug. 6, 1969. Priority date July 8, 1965, Austria.

A method for the production of metal or metal compound spheres is described. The metal or metal compound is suspended in a liquid bonding agent which is sprayed thereby solidifying the droplets. The metals in groups IVA, VA, or VIA are preferred. (J.R.D.)

38951 A METHOD OF FORMING A JOINT BETWEEN A TUBE AND A FITTING. (to Atomic Energy of Canada Ltd.). British Patent 1,160,407. Aug. 6, 1969. Priority date Nov. 9, 1966, United States.

A method of joining metal tubes having low ductility is described. A fitting is machined to provide an interface area with a chosen profile, the tube is aligned with the fitting adjacent to the interface area and a ring is engaged against the interface distorting the ring and tube plastically, the ring thereby exerts pressure on the tube effecting a sealing bond between the tube and the fitting. (J.R.D.)

38952 LEVITATION MELTING: A PREPARATION TECHNIQUE FOR REFERENCE SAMPLES. Van Audenhove, Jan (Central Bureau for Nuclear Measurements, Geel, Belgium). Euro-Spectra, 8: 46-9(June 1969).

Induction heating in which a magnetic field is set up and used to obtain levitation of the material to be evaporated without any physical contact is described. The technique is used to obtain

pure coatings of U, Th, and Al. It is also used to prepare reference alloys. (J.R.D.)

38953 APPLICATIONS OF ULTRASONIC WELDING IN NUCLEAR ENGINEERING. Zuern, H. (Schweisstechnische Lehr- und Versuchsanstalt, Mannheim, Ger.); Richter, H. Kerntechnik, 11: 276-80(May 1969). (In German and English).

Ultrasonic welding is a bonding technique similar to cold-press welding and to friction welding and based on the simultaneous application of high frequency mechanical vibration and of pressure. Its main applications are for bonding metals and plastics of relatively small dimensions in the laboratory and in serial fabrication in the fields of electrical engineering, electronics, precision-mechanics, the packaging industry, etc. Among the specific problems for which ultrasonic welding is particularly suited are various bonding problems in the field of nuclear engineering, mainly in prototype work, such as the connection of thermocouples to fuel element plates, the welding together of thin foils of dissimilar metals in radiation experiments, and other similar problems. The technique will no doubt remain limited to special application fields, but development work continues. (auth)

38954 PRECISION DEBURRING BY ECD [ELECTROCHEMICAL DEBURRING]. Michaels, Gordon. Prod. Finish. (Cincinnati), 33: No. 4, 48-54(Jan. 1969).

Electrochemical deburring is being used more widely in precision work because it offers precision metal removal even in hard-to-reach areas with little disturbance of critical tolerances in surrounding areas and can be used to deburr even the hardest metals and alloys (Mo, W and Ti). The design and operation of an electrochemical deburring system are discussed and illustrated. Variables discussed include electrode design, operation sequence, automatic handling, machine capacity, maintaining the electrolyte, temperature control, current density, flow rate, electrolytes and costs. Applications in the automotive industry are discussed. (Metals Abstr.)

Properties Evaluations

Refer also to abstracts 37957, 38138, 38143, 38162, 38173, 38220, 38925, and 38948.

38955 (COO-841-18) DIFFUSION STUDIES IN LIQUID METALS. Progress Report, June 16, 1968-June 15, 1969. Swalin, R. A. (Minnesota Univ., Minneapolis. Inst. of Tech.). June 15, 1969. Contract AT(11-1)-841. 7p. Dep. CFSTI.

Research progress is reported on determination of radial distribution function in alkali metals, mechanisms of thermotransport in silver alloys, self-diffusion of substances at constant volume, and diffusion of solutes in Ag. (J.R.D.)

38956 (GEMP-696) HIGH TEMPERATURE SPECIFIC HEAT OF BODY-CENTERED-CUBIC REFRACTORY METALS. Hoch, M. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). Feb. 7, 1969. Contract AT(40-1)-2847. 32p. Dep. CFSTI.

High temperature enthalpy data on chromium, niobium, tantalum, rhenium, molybdenum, and tungsten were evaluated taking into consideration higher order anharmonic contributions to the specific heat. It was found that at high temperatures, ($T > \theta_D$) the enthalpy can be expressed as: $H_T - H_{298} = 3R\,(T + \theta_D^2/20T) - 3R\,(298 + \theta_D^2/20 \times 298) + bT^2 + dt^4$. This equation represents the enthalpy and its derivative the specific heat up to within 100°K of the melting point. The constant d is related between the various metals in such a fashion that dT_{mp}^4 is equal in all metals, where T_{mp} is the melting point temperature. The equation contains only three coefficients which are determined by experiment. Previous interpretations used an equation of the type $H_T - H_{298} = r + pT + qT^2 + \Delta H_f \exp(\Delta S_f/R - \Delta H_f/RT)$, which contains five coefficients to be determined by experiment. Accurate enthalpy or specific heat data, close to the melting point, are required for calculation of defect formation energies and concentrations from high temperature enthalpy or specific heat measurements. (auth)

38957 (KAPL-P-3813) EFFECTS OF EXTERNAL LOAD ON CAVITATION DAMAGE. Kemppainen, Dale J.; Hammitt, Frederick G. (Michigan Univ., Ann Arbor. Lab. of Cavitation and Multiphase Flow). Mar. 1969. 32p. (CONF-690902-1). Dep. CFSTI.

From IAHR Symposium, Kyoto, Japan.

Cavitation damage rates in an ultrasonic cavitation field upon specimens subjected to an externally applied stress are reported. Brass, bronze, aluminum, magnesium, copper, stainless steel, and carbon steel were tested in cold water under tensile and compressive stresses of ¾ of their yield strength, and in one case at twice that value. Damage rates under stress were compared with those for identical specimens under zero load. Generally it was found that compression tends to reduce damage during the constant damage rate portion of the test, while tension increases it. The same trends were found for the very early part of the test. However, the magnitude, and in some cases the direction of the trend, differed for different materials. Measurements were also made on the effects of a given cavitation volume loss upon the yield and tensile strength of the specimens. In general it was found that the effect is much greater than that which would be predicted on the basis of an exactly uniform damage distribution (mean depth of penetration) across the specimen. (auth)

38958 (ORNL-TM-2584) TECHNIQUE FOR MEASURING THE DIFFUSIVITY AND SOLUBILITY OF GASES IN METALS WITH APPLICATION TO NITROGEN IN TUNGSTEN. Wagner, Richard Louis (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 45p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

An ultrahigh vacuum technique, suitable for the determination of the solubility, diffusivity, and permeability of gases in metals is described as applied to nitrogen-tungsten systems. The method depends on the measurement of the degassing rate of nitrogen as a function of time from resistivity heated wire specimens, previously equilibrated in nitrogen at 1 to 25 torr, with a mass spectrometer and a known vacuum conductance. The diffusion constant, D, and the solubility constant, S, between 1000 and 1800°C may be summarized in Arrhenius form by $D = (2.37 \pm 0.43) \times 10^{-3} \exp[(-35{,}800 \pm 3900)/RT]$ cm²/sec and $S = (0.21 \pm 0.06) \exp[(-17{,}600 \pm 5900)/RT]$ torr · liter cm^{-3} $torr^{-½}$. The permeation constants calculated from these results agree within a factor of two with directly measured values reported in the literature. The diffusion constants agree within a factor of three with literature values, although the activation energies for diffusion (35,800 – 62,000) are quite different. The solubility obeys Sievert's law and exhibits a positive activation energy for solution. The concentration of nitrogen in tungsten at 1 atm pressure according to the solubility constant is 0.4 ppM at 1000°C and 9.2 ppM at 2000°C. The permeability of nitrogen through tungsten is two orders of magnitude lower than the permeability of nitrogen through molybdenum and five orders of magnitude lower than the permeability of nitrogen through niobium or tantalum. (auth)

38959 (RD/B/N-1151) BONDED BAR AND SLEEVE REINFORCED PENETRATIONS IN CONCRETE SLABS. O'Connell, J. M. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). May 1969. 25p. Dep.

The current series of gas-cooled reactors contain a number of large circular penetrations set in the walls of the prestressed concrete pressure vessels. Methods of reinforcing these penetrations vary; in some instances a steel sleeve is used, in others bonded bars are preferred. Information relating to stresses and deformations at penetrations which are reinforced with a steel sleeve or bonded steel rings is given. (auth) (UK)

38960 CHEMISORPTION ON RHENIUM: N_2 AND CO. Yates, John T. Jr.; Madey, Theodore E. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 51: 334-47 (July 1, 1969).

The chemisorption of N_2 and CO on polycrystalline Re has been studied using flash desorption. A number of binding states have been identified and their binding energies have been estimated kinetically. Isotopic mixing between chemisorbed species has been observed for the $\beta-N_2$ and $\beta-CO$ states on Re; there appears to be no evidence for dissociation of $\beta-CO$. The $\gamma-N_2$ and two $\alpha-CO$ states on Re desorb without isotopic mixing. In general, the distribution and properties of binding states for N_2 and CO on Re are remarkably similar to those found for these adsorbates on W. An enhancement in nitrogen adsorption on Re occurs upon electron impact (150 eV) on $N_2(g)$. A new set of strongly bound states are produced which are distinct from the $\beta-N_2$ states populated by adsorption of ground-state $N_2(g)$. A comparison of the sticking coefficients for N_2 and CO on Re is made, using two independent methods (uptake and isotopic mixing) over a wide temperature range. The sticking coefficient for N_2 on Re decreases markedly with increasing temperature; for CO on Re, there is little effect of temperature on the sticking coefficient. A discussion is presented of migration-limited bimolecular kinetics at elevated temperatures in the chemisorbed layer. (auth)

38961 DIFFUSION CREEP IN ZIRCONIUM, ZIRCALOY-2 AND ATR. Hesketh, R. V. (Central Electricity Generating Board, Berkeley, Eng.). Colloq. Met., Commis. Energ. At. (Fr.) 11th, 1967, 174(1968).

From 11th Symposium on Metallurgy (Creep), Saclay, France. See CONF-670664.

Tests were made on material which had been recrystallized at 660°C and slowly cooled. The tests were made in Ar at 500 to 600°C in tension on sheets. Below 2000 psi in Zr and below 3000 psi in Zircaloy-2. The steady creep rate was found to be linearly proportional to stress. An equation to describe the creep rate is included along with values for activation energies in the diffusion creep range. (J.R.D.)

38962 RELATIONSHIP BETWEEN ACTIVATION ENERGIES AND DEFORMATION MECHANISMS IN URANIUM CREEP. Grenier, P.; Lacombe, P. (Ecole des Mines, Paris). Colloq. Met., Commis. Energ. At. (Fr.) 11th, 1967, 39-41(1968). (In French).

From 11th Symposium on Metallurgy (Creep), Saclay, France. See CONF-670664.

Measurements of activation energy for creep and study of its variations versus temperature along with micrographic examination of samples after creep and examination of curves related to time-elongation revealed that the mechanism which controls polycrystalline electrolytic uranium strain at 325 to 415°C and monocrystalline material at 325 to 450°C, is carried out by a (010) [100] slip deflected by a (001) [100] slip. (auth)

38963 HERRING–NABARRO CREEP FOR BERYLLIUM MONOCRYSTALS COMPRESSED ALONG THE C AXIS. Le Hazif, R.; Antolin, J.; Dupouy, J.-M. (CEN, Saclay, France). Colloq. Met., Commis. Energ. At. (Fr.) 11th, 1967, 87-96(1968). (In French).

From 11th Symposium on Metallurgy (Creep), Saclay, France. See CONF-670664.

Compression test results showed that there was no pyramidal slip with a direction out of the basal plane in beryllium. Consequently if a single crystal is compressed along the c axis there is no available glide or twinning mode since the basal or prismatic planes are not sheared. The presence in the basal planes of numerous loops with a c Burgers vector were noted. Such loops are formed during the compression by the condensation of point defects. Compression creep tests were carried out in the temperature range 350 to 500°C at loads of 30 to 80 kg/mm^2. The creep rate increases steadily and can reach values as high as 10^{-4}/sec. Electron micrographs after large deformations (10 to 20%) indicate that the single crystals are subdivided into small cells (2 to 3 μ) limited by dislocation walls along prismatic planes and c loops on the basal planes. It is clear that the specimens deform by the flow of vacancies from the cell walls to the c loops where the vacancy concentration is $C_0 \exp[-(\sigma b^3/kT)]$ smaller than the equilibrium concentration. After an initial period where the deformation is not well defined the creep follows a law of the type: $\epsilon = kt^n$ with n between 2 and 3.5. The Nabarro creep equation is established as $\dot{\epsilon} = \alpha\,(D/l^2)\,\frac{Sh}{}\,(\sigma b^3/kT)$ with the known values of D, σ and ϵ one gets for $(l/\sqrt{\alpha})$ values in excellent agreement with the observed cell dimensions. (auth)

38964 INFLUENCE OF BORON ON THE CREEP-RESISTANCE PROPERTIES OF AN AUSTENITIC NICKEL–CHROMIUM ALLOY HARDENED BY STRUCTURAL PRECIPITATION. Richards, E. G.; Twigg, P. L. (International Nickel Co., Ltd., Birmingham, Eng.). Colloq. Met., Commis. Energ. At. (Fr.) 11th, 1967, 97-102(1968). (In French).

From 11th Symposium on Metallurgy (Creep), Saclay, France. See CONF-670664.

A detailed study has been made of the effect of boron on the structure and the properties of an austenitic alloy containing Fe, 42% Ni, 16% Cr, 3% Mo and hardened by 1.5% Ti and 1.25% Al. It has been found that boron improves the stress rupture life by decreasing the minimum creep rate, by delaying the appearance of tertiary creep and by increasing the strain in this last phase of creep. Structural studies have been carried out showing differences in the form of the deformation in regions adjacent to the creep fracture. Carbide precipitation at grain boundaries has been followed by measurement of the impact energy and by examination of the fractures by the replica technique. It was found that the final morphology of the carbides is not modified by the presence of boron, but that its effect is to slow down precipitation. The growth of the γ' phase, Ni_3 (Ti, Al) which causes the structural hardening has also been measured. The mechanism by which boron improves the creep-resistance characteristics is discussed in relation to the structural modifications observed. (auth)

38965 STUDY OF CREEP MECHANISM IN BERYLLIUM BETWEEN 300 AND 800°C. Petrequin, P. (CEN, Saclay, France). Colloq. Met., Commis. Energ. At. (Fr.) 11th, 1967, 163-71(1968). (In French).

From 11th Symposium on Metallurgy (Creep), Saclay, France. See CONF-670664.

Polycrystalline beryllium of two different purities and beryllium alloyed with 0.6% copper have been made to creep in the temperature range between 300 and 800°C using stresses of from 300 to 10,000 g/mm^2. It was found that at high temperature (>400°C) the creep mechanism has a high activation energy (65,000 cals/mole or 2.8 eV). The linear creep rate depends on the stress according to a σ^n law. The coefficient n is of the order of 3 for beryllium and of about 4 for beryllium containing 0.6% Cu. At temperatures lower than 400°C the creep activation energy is very close to that of beryllium autodiffusion, i.e. 39,000 cals/mole or 1.6 eV. Above 400°C there is little grain deformation and numerous cavities are to be observed on the grain boundaries after rupture. Below 400°C however, the grains are very much deformed and cavities only occur in the fracture zone. (auth)

38966 EFFECT OF THERMAL CYCLING ON URANIUM ALLOYS CREEP. ROLE OF INTERNAL STRESSES. Andre, J.-P.; Decours, J.; Le Bret, P. (CEN, Saclay, France). Colloq. Met., Commis. Energ. At. (Fr.) 11th, 1967, 19-28(1968). (In French).

From 11th Symposium on Metallurgy (Creep), Saclay, France. See CONF-670664.

The deformation of various uranium alloys has been studied under conditions producing creep at constant load and with thermal cycling. The classification of the alloys is in good agreement with that based on the creep-resistance at the maximum temperature of the cycle. A study of the influence of the applied load on the overall deformation rate shows that this latter varies with the square of the load. A more detailed study has been undertaken of the alloy UMo 1.1, Al 0.05, Sn 0.05 with a view to defining the effects on the deformation during a cycle of the maximum temperature and the amplitude of the temperature cycle. The results are interpreted in terms of the microstructural changes occurring in the alloys and are compared with results obtained on uranium by British workers. (auth)

38967 STUDY OF THE DIFFUSION BETWEEN ALUMINUM AND NIOBIUM. Brossa, F.; Musso, G.; Schleicher, H. W. (EURATOM–CCR, Ispra, Italy). Met. Ital., 61: 167-72(Apr. 1969). (In Italian).

Compatibility tests between aluminum and niobium have been expected between 500 and 640°C, in order to determine the maximum temperature for the utilization of these metals in an intimate contact. The couples have been prepared mostly by evaporation by electron bombardment of Nb onto Al sheets. Some couples however were realized by chemical vapor deposition of Nb by reduction of $NbCl_5$. The samples have been heat-treated under vacuum for durations up to 580 days. The width of the penetration bands has been measured microscopically and the composition has been analyzed by the electron microprobe. The penetration parameters have been calculated on the IBM computer 7090 using a program established previously. Some examples for the use of niobium diffusion barriers are described. (auth)

38968 EFFECT OF ZIRCONIUM GETTERING ON BIAXIAL STRESS RUPTURE PROPERTIES OF AUSTENITIC STAINLESS STEELS IN SODIUM. Lee, William T. (Atomics International, Canoga Park, Calif.). Nucl. Appl., 7: 155-63(Aug. 1969).

The stress-rupture properties of austenitic stainless steels in high purity static liquid sodium were studied. Zirconium foil was placed in the sodium to getter oxygen and maintain a high purity sodium environment throughout the test. Results of the biaxial stress-rupture tests on thin-walled Types 304 and 316 stainless steel tubing in the range 1200°F (649°C) to 1400°F (760°C) showed that the rupture strength of the tubing was significantly lower in the zirconium-gettered static sodium than in non-gettered static sodium or helium. This reduction in rupture strength was greater with higher test temperature and longer exposure time. In the presence of sodium, the zirconium foil decarburized the stainless steel; the decarburization process also resulted in an extensive sigma phase formation on the region of the tubing exposed to sodium. The decarburization increased with test temperature and time of exposure. It was concluded that the decreased stress-rupture strength of specimens tested in zirconium-gettered sodium was caused by decarburization of the stainless steel. (auth)

38969 SOLUTION AND DIFFUSION OF HYDROGEN IN TUNGSTEN. Frauenfelder, R. (Westinghouse Research Labs., Pittsburgh). J. Vac. Sci. Technol., 6: 388-97(May-June 1969).

Using mass spectroscopic and ultrahigh vacuum techniques, solution and diffusion of hydrogen in tungsten were investigated for pressures between 600 and 10^{-9} torr and temperatures between 1100 and 2400°K. Solubility and diffusion constants were derived from degassing rates of a solid cylinder which was pre-loaded with hydrogen at ≈600 torr. The solubility constant, $S = 2.9 \times 10^{-1} \times \exp(-24{,}000/RT)$ torr liter/cm^3 torr$^{\frac{1}{2}}$, and the diffusion

constant, $D = 4.1 \times 10^{-3} \times \exp(-9000/RT)$ cm²/sec, were obtained, which in conjunction with literature values for the permeation constant P were consistent with the equation P = SD. Comparison to theory indicates that the solubility and diffusion constants are characteristic of interstitially dissolved hydrogen. Expressions were derived for the concentration of interstitial hydrogen as a function of pressure and temperature. Semiquantitative values for the total hydrogen concentration at low pressures were derived from H_2 pressure changes which result when a sample is flashed between selected, high temperatures. Below 10^{-4} torr, the total hydrogen concentration appeared to be several orders of magnitude higher than the concentration of interstitial hydrogen, indicating that hydrogen is held in, and diffuses via both interstitial sites and a second kind of site of unknown nature. A semiquantitative analysis of diffusion is given for the case of the diffusing species held in, and diffusing via, two different kinds of sites. (auth)

38970 EQUATION OF STATE OF SHOCK-LOADED TUNGSTEN AT 950°C. Rohde, R. W. (Sandia Labs., Albuquerque, N. Mex.). J. Appl. Phys., 40: 2988-93(June 1969).

The Hugoniot of wrought tungsten which was 99.6% of the crystalline density and 99.92% pure was determined to 80 kbar at room temperature and at 950°C. Measurements of the stress-particle velocity relationship were made by impacting a sapphire-faced quartz gage assembly onto the tungsten sample. In the room temperature experiments, transmitted wave profiles were determined with quartz gages. At room temperature, the elastic wave velocity was 5.22 ± 0.05 mm/μsec and the Hugoniot elastic limit for 9.5 mm thick specimens was 37.7 ± 0.8 kbar. The stress-particle velocity Hugoniot at 950°C, while nearly parallel to the room temperature Hugoniot, was displaced about 15 kbar downward due to a decrease in the Hugoniot elastic limit at this temperature. This decrease is associated with a temperature induced brittle-ductile transition. The application of these data in calculating the Grüneisen parameter is discussed. (auth)

38971 THE INTERACTION COEFFICIENTS γ_x^o, ϵ_x^x, AND e_x^x OF Fe-x BINARY SYSTEM AT STEELMAKING TEMPERATURES. Buzek, Zdenek; Schindlerova, Vera. Sb. Ved. Pr. Vys. Sk. Banske Ostrave, Rada Hutn., 13: 165-73(1967). (In Czech).

Possible methods of determining γ_x^o coefficients are analyzed and discussed. Concentration dependences of the activities and of log γ_x in systems Fe–Zr, Fe–Ti, Fe–Y, Fe–Nb, Fe–Ta, Fe–Hf, and Fe–U were used to determine the corresponding γ^o, ϵ_x^x, and e_x^x values and the temperature dependence of the γ_x^o and ϵ_x^x coefficients. (Metals Abstr.)

38972 ELECTRIC-TRANSPORT OF ADSORBED THORIUM ATOMS AND BARIUM OXIDE MOLECULES ON THE (113) FACE OF A TUNGSTEN SINGLE CRYSTAL [AND A METHOD OF STUDYING THE MIGRATION OF ADSORBED ATOMS AND MOLECULES]. Vedula, Yu. S. Uk. Fiz. Zh., 14: 132-7(Jan. 1969). (In Russian).

A method of studying the electric transport (migration) of adsorbed atoms and molecules on the surface of large W single crystals is described. The method is based on measuring changes in work function with the help of a mobile electron gun and is chiefly applicable to adsorbed particles which produce large changes in work function. Examples are given for Th atoms and BaO molecules on the (113) face of a W single crystal. The Th atoms move in the direction of the anode, owing to the effect of the "electron wind." The BaO molecules move little if at all. 14 references. (Metals Abstr.)

38973 EFFECT OF THE DEGREE OF WORKING ON THE CREEP-RUPTURE STRENGTH OF MOLYBDENUM COMPOSITE-CAST OF HEAT-RESISTANT ALLOYS. Yoda, Renpei; Arai, Takashi (National Research Inst. for Metals, Tokyo). Nippon Kinzoku Gakkaishi, 33: 699-705(1969). (In Japanese).

Investigation was made on the effect of the working degree on the creep-rupture strength of molybdenum specimens coated with the nickel-base heat-resistant alloy Nimonic 90 and specimens coated with the cobalt-base heat-resistant alloy S-816 subjected to casting and 25 to 80% hot-working at 1000 and 1150°C. The creep-rupture strength was improved as the working degree was increased, but it was deteriorated adversely by heavy working such as 80% reduction, due to the lowering of the recrystallization temperature of molybdenum; this tendency became marked with lowering working temperature. When the working degree is small, the high stress and short-time strength is low but the deterioration of the low stress and long-time strength is small. Molybdenum coated with S-816 alloy has usually a superior short-time strength, but an inferior long-time strength compared with molybdenum coated with Nimonic 90 alloy under the same reduction by working. Molybdenum shows ductile fracture under the high stress and short-time test, but shows brittle fracture through the grain boundary of molybdenum under the low stress and long-time test because of the recrystallization of molybdenum. The recrystallization temperature of molybdenum worked at 1000 is around 1100 at 80% working and around 1150°C at 65% working, and the strain of molybdenum worked heavily is recovered easily by heating until 1150°C and molybdenum is softened, but worked properly can be sustained up to a considerably high temperature. Accordingly, for improving the long-time creep-rupture strength of the composite materials, hot workings of 30 to 40% at 1000°C and 40 to 60% at 1150°C are optimal. (auth)

38974 THE SELF-DIFFUSION OF OXYGEN IN BERYLLIUM OXIDE BY PROTON ACTIVATION OF ^{18}O. Bradhurst, D. H.; De Bruin, H. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Aust. Ceram. Soc., 5: 21-7(May 1969).

The self-diffusion of oxygen in beryllium oxide was measured using the stable isotope ^{18}O in conjunction with a new method for oxygen analysis in which the ^{18}O concentration was determined by proton activation and autoradiography. The diffusion data obtained suggest that the oxygen diffusion process in high density compacts of beryllium oxide occurs predominantly by lattice diffusion in the temperature range 1400 to 1900°C. (auth) (Australia)

38975 THE LASER MICROPROBE APPLIED TO INVESTIGATION OF SODIUM PENETRATION INTO STAINLESS STEEL. Sowa, Edmund S. (Argonne National Lab., Ill.). Nucl. Appl. Technol., 7: 100-5(July 1969).

An investigation was performed on possible penetration of sodium into Type 304L stainless steel grain boundaries when the steel was exposed to the liquid metal at 1200°F. The method used consisted of progressive penetration with a laser through sodium-filled thin wall stainless steel tubes ~0.0005 inches at a time. Simultaneous recording of the emission spectrum of each sample on photographic film resulted in production of a comparative record which was analyzed for the intensity of the sodium 5890 to 5895.5 Å doublet. Entry into a sodium-rich region was attended with intensification of the sodium lines. Results with a series of tubes exposed to sodium at 1200°F up to 1425 hours and compared with a control sample not treated at 1200°F did not show any evidence of sodium penetration through 304L stainless steel. (auth)

38976 SOLUBILITY OF URANIUM AND PLUTONIUM IN LIQUID ALLOYS. Johnson, Irving (Argonne National Lab., Ill.). Nucl. Met., Met. Soc. AIME, 15: 547-64(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

A method is presented for estimation of the solubility of uranium or plutonium in liquid ternary alloys. This method requires information on the phase relations and thermodynamics of three binary systems. The method also may be used to determine the approximate stoichiometry of the solid phase in equilibrium with the liquid alloy. The method is illustrated by analyses of the experimental data for the solubility of uranium in liquid zinc–magnesium–uranium and plutonium in liquid zinc–magnesium–plutonium alloys. (auth)

38977 THERMODYNAMIC PROPERTIES OF SELECTED SOLUTES IN LIQUID METAL SOLUTIONS. Bowersox, David F. (Los Alamos Scientific Lab., N. Mex.). Nucl. Met., Met. Soc. AIME, 15: 565-75(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

The partial molar enthalpies of solution, $\Delta\overline{H}_i^*$, were calculated for selected elements in liquid plutonium from solubility data over the temperature range 700 to 1000°C. The enthalpies of solution of vanadium, chromium, niobium, molybdenum, tantalum, and tungsten were calculated from regular solution theory by the equation $\Delta\overline{H}_i^* = T\Delta S_f - RT \ln N_i$, where T is the absolute temperature, ΔS_f is the entropy of fusion of i at the normal melting temperature, R is the gas constant, and N_i is the mole fraction of solute i in a saturated solution at temperature T. The enthalpies of solution of tungsten and tantalum in sixteen liquid rare earth metals were also calculated by this equation. Solubility parameters, δ_i, were calculated from these enthalpies. Finally, partial molar enthalpies of solution of carbon, titanium, zirconium, thulium, and rhenium were calculated. (auth)

38978 THERMODYNAMICS OF FORMATION OF Th_2F_{11}, Th_2Co_{11}, Th_2Ni_{11}, $ThCo_3$, $ThNi_3$, $ThCu_4$, AND $ThNi_2$ FROM ELECTROMOTIVE FORCE MEASUREMENTS. Magnani, N. J.; Skelton, W. H.; Smith, J. F. (Ames Lab., Iowa). Nucl. Met., Met. Soc. AIME, 15: 727-42(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Solid electrolyte electromotive force cells were used to determine the Gibbs free energies, entropies, and enthalpies of forma-

tion of several binary phases of thorium with iron, cobalt, nickel, or copper. CaF_2 was employed as the electrolyte, and it is an ionic conductor over the temperature range of the measurements, 600 to 850°C. The data indicate a decreasing stability of intermediate phases with defined stoichiometry, Th_xM_y, as M changes from nickel to cobalt to iron. The data further indicate that the Gibbs free energies of formation per g-atom of thorium are nearly constant for the thorium-poor phases within a given system. This latter observation is compatible with crystallographic information, which shows that the near-neighbor atomic coordination around the thorium atoms in the thorium-poor phases consists exclusively of transition-metal atoms with the coordination geometries being closely comparable from phase to phase. The crystallographic data also show bond distances that are compatible with the order of stability with the greatest relative contraction occurring for thorium–nickel bonds, intermediate for thorium–cobalt bonds, and least for thorium–iron bonds. (auth)

38979 THE ACTIVITY OF ZIRCONIUM, TITANIUM, YTTRIUM, HAFNIUM, TANTALUM, URANIUM, NIOBIUM, AND IRON IN THE SYSTEMS Fe–Zr, Fe–Ti, Fe–Y, Fe–Hf, Fe–Ta, Fe–U, and Fe–Nb AT 1600°C. Schindlerova, Vera; Buzek, Zdenek. Sb. Ved. Pr. Vys. Sk. Banske Ostrave, Rada Hutn., 13: 157-64 (1967). (In Czech).

A technique outlined previously was used to determine the concentration dependence of the activities in several Fe systems. The reaction coefficients γ_X^0 and γ_{Fe}^0 were determined from the concentration dependences of $\log \gamma_X$ and $\log \gamma_{Fe}$. (Metals Abstr.)

38980 PROPERTIES OF Cu-20 PERCENT Ni–Be AND–Cr ALLOYS. Suzuki, Hisashi; Ueki, Mitsuo (Tokyo Univ.). Nippon Kinzoku Gakkaishi, 33: 724-9(1969). (In Japanese).

A study was undertaken for the purpose of obtaining the material having an excellent spring property and high corrosion resistance. Mechanical properties of Cu–20% Ni alloys containing various amounts of Be and Cr respectively, have been investigated. These alloys were cast, hot-worked, solution-treated at various temperatures, cold-worked at 60 to 90% to 0.5 mm thickness, and subsequently aged at various temperatures for various times. It was found that the properties in the aged state such as the spring or other mechanical properties of Cu–20% Ni alloys were sharply improved by adding a small amount of Be. The alloy containing about 0.4% Be showed a maximum value of about 110 kg/mm² in Kb, when it was solution-treated at 1050°C, quenched, cold-worked, and then aged at 400 to 500°C for 1 hr. The values of Kb obtained for the alloys containing Cr amounted to about 70 kg/mm² at most. It was confirmed that the alloys containing Be and Cr were age-hardened due to the precipitation of NiBe(super lattice) and Cr, respectively. The mechanical properties of the alloys containing Be attained a maximum, when NiBe was in the state of G-P precipitation plus intermediate phases. The stress corrosion resistance of both alloys was much superior to that of nickel-silver. It has been concluded that the commercially available nickel-silver can be replaced by the alloys containing a small amount of Be. (auth)

38981 INFLUENCE OF SODIUM ON CREEP BEHAVIOUR AT ELEVATED TEMPERATURES FOR CERTAIN STAINLESS STEELS. Beaufrere, J.; Valibus, L. Mem. Sci. Rev. Met., 66: 433-43(May 1969). (In French).

Results of tests carried out on steel Z 6 CND 17.13 at 700°C for times of the order of 3,000 hr are given. The influence of sodium on the creep behavior of this steel is low compared with other effects, particularly those of irradiation. However, the testing time could be increased. (auth)

38982 PRESSURE TESTS OF CYLINDRICAL STEEL PRESSURE VESSELS REINFORCED WITH STEEL WIRE WRAPPING. Bower, John E. (United States Steel Corp., Monroeville, Pa.). Nucl. Eng. Design, 9: 421-38(Apr. 1969).

To examine the bursting-strength and crack-arrest benefits that may be gained by adding circumferential wire wrapping on a cylindrical steel pressure vessel, four wire-wrapped steel vessels were pneumatically, internally pressurized to failure. Two of the vessels had intentional notch-type defects in the cylinder wall, one had notch-type defects in the wire, and one had no defects. The tests showed that circumferential wire wrapping limits the total extension and rate of extension of longitudinal cracks and restrains crack propagation. Also, the bursting pressure of a wire-wrapped cylinder is greater than that for a nonwrapped cylinder of similar wall thickness and approaches that for a nonwrapped sphere. Wire-wrapped cylindrical vessels may provide both cost and weight savings over a similar nonwrapped vessel of equal strength. The aspects of increased fracture toughness and increased bursting strength would certainly be beneficial concepts in reactor pressure vessels. (auth)

Structure and Phase Studies

38983 (COO-916-15) STRUCTURE AND PROPERTIES OF SOLID SOLUTIONS. Technical Progress Report No. 9, March 1, 1968–June 15, 1969. Hendrickson, A. A.; Chen, C. C. (Michigan Technological Univ., Houghton. Dept. of Metallurgical Engineering). Contract AT(11-1)-916. 22p. Dep. CFSTI.

Research effort on the development of experimental techniques for the measurement of dislocation velocities in silver and silver solid solutions is reported. A modified Czochralski method was used in the growth of low dislocation density, seeded silver crystals at densities as low as $10^3/cm^2$. High temperature annealing yields crystals with only 100 dislocations per cm^2. A crystal cutting and polishing process consisting of erosion spark cutting and subsequent mechanical and chemical polishing was established to obtain rectangular parallelepiped crystals with strain free (111) surfaces. A magnetic stress pulsing apparatus was designed and constructed for stressing crystals over small time durations. These techniques are now being applied to study the characteristics of dislocation motion in silver crystals. (auth)

38984 (SU-326-P-17-36) STRUCTURE DEPENDENCE OF HIGH TEMPERATURE DEFORMATION OF METALS. Progress Report for the Period March 1, 1968–March 1, 1969. Barrett, Craig R.; Nix, William D. (Stanford Univ., Calif. Dept. of Materials Science). Contract AT(04-3)-326. 42p. Dep. CFSTI.

Experiments on shock loading effects on creep of Ni–20 Cr–4.5 Al alloy are reported in which data were gathered that indicate creep strengthening by shock loading is technically feasible. Results of investigations concerned with the theoretical aspects of creep structural dependence are discussed including the structure dependence of Newtonian deformation in metals. Data are included on creep of Ni–20 Cr–4.5 Al alloys and creep of Ni–6% W alloys. (J.R.D.)

38985 NEW TERNARY COMPOUNDS IN THE SYSTEMS (Sc, Ti, Zr, Hf)–(V, Cr, Mn, Fe, Co, Ni, Cu)–(Al, Ga). Markiv, V. Ya.; Burnashova, V. V. Dopv. Akad. Nauk Ukr. RSR, Ser. A., No. 5, 463-4(May 1969). (In Ukrainian).

The systems (Sc, Ti, Zr, Hf)–(V, Cr, Mn, Fe, Co, Ni, Cu)–(Al, Ga) were investigated by means of x-ray and microscopic analyses to establish the ternary compounds having Zr_6FeAl_2, $ThMn_{12}$, Th_6Mn_{23}, $ZrCoAl_4$, and $Zr_5Ni_6Al_{16}$ structure types. A number of new ternary compounds were found. (auth)

38986 HIGH PRESSURE CRYSTAL GROWTH OF ALPHA PLUTONIUM. Liptai, R. G.; Friddle, R. J. (Argonne National Lab., Ill.). J. Cryst. Growth, 5: 216-18(June 1969).

Large single crystals of α Pu were grown from the solid-state phase transformation β to α at pressures of 55 kbar. A belt-type high-pressure apparatus was used. Specimens were prepared by rolling at a temperature that corresponds to the β phase, 150°C, cooling in silicone oil to room temperature, and machining to size. Total impurity content, exclusive of Am, was 300 ppM by weight; the Am content, which was due to decay of ^{241}Pu, was about 200 ppM at the time of the experiments. After insertion of the cell assembly into the pressure apparatus, the pressure was increased to 55 kbar. The sample was quickly heated to 480°C and maintained at 480°C for 1 to 2 days. Then the sample was cooled through the $\beta \rightarrow \alpha$ transformation at a rate of 40°C/hr to 400°C, held at this temperature for 1 to 5 days, cooled to room temperature, and depressurized. The back-reflection Laue photogram of one of the surfaces showed individual spots free of asterism, which indicates a strain-free condition, as opposed to continuous and diffuse Debye rings observed on x-ray patterns of the rolled material. When samples were surrounded by a solid, pressure-transmitting medium such as BN, severe subgraining occurred at all pressures. Crystallographic aspects are believed to play a significant role in the growth of large crystals from the β phase. The size of the crystals produced is limited to the maximum specimen size that can be accommodated in the high-pressure belt apparatus. The maximum size obtained has corresponded to 75% of the specimen volume. Subgraining remains a problem. However, the orientation difference is usually less than 0.5° and the subgrains are relatively large. (BBB)

38987 STUDY ON DIFFUSION OF CARBON IN TANTALUM AND AND ZIRCONIUM BY X. M. A. Suzuki, Hiroshige; Kimura, Shushichi (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 90, 105-15(Mar. 1969).

Tantalum (grain size ~500 μ) and zirconium (grain size 15 to 45 μ) contacting with carbon were diffusion annealed at 1600 to 1900°C and 1100 to 1700°C, respectively. After carbon concentration-distribution curve was measured, volume diffusion coefficients of carbon in tantalum and zirconium were obtained

using an electron-probe microanalyzer as follows; Ta : $D_v = 8.54 \times 10^{-4}$ exp (−52,500/RT) cm^2/sec and Zr : $D_v = 1.40 \times 10^{-4}$ exp (−30,000/RT) cm^2/sec. Grain size of zirconium was about the same with an expected region characteristic x-ray excited by electron beam, so that both volume diffusion and grain-boundary diffusion were revealed on carbon concentration curve. Then separating both diffusion effects graphically, and applying Fisher's equation, the grain-boundary diffusion coefficient D_{gb} was calculated as Zr : $D_{gb} = 2.35 \times 10^{-1}$ exp (−24,100/RT) cm^2/sec. The ratio of grain-boundary diffusion coefficient D_{gb} to volume diffusion coefficient D_v of carbon in zirconium was nearly 10^6 over a wide range of temperature. This implies that grain-boundary diffusion coefficient is considerably larger than volume diffusion coefficient. (NSA of Japan)

38988 CONSTITUTION DIAGRAM OF Nb-Al SYSTEM. Svechnikov, V. N.; Pan, V. M.; Latysheva, V. I. (Inst. of Metal Physics, Kiev). pp 54-61 of Fazovye Prevrashcheniya. Svechnikov, V. N. (ed.). Metallofizika 22. Kiev, Naukova Dumka, 1968. (In Russian).

A constitution diagram of Nb−Al alloy revealed a wide range of solid Nb-base solutions (at up to 24 at. % Al at 1820°C). A homogeneous σ-phase was found for Nb_2Al compound at 1450°C and 32.5 to 40 at. % Al. (R.V.J.)

38989 POLYMORPHIC STATE ON INTERMETALLIC COMPOUND $ZrCr_2$. Svechnikov, V. N.; Spektor, A. Ts. (Inst. of Metal Physics, Kiev). pp 64-72 of Fazovye Prevrashcheniya. Svechnikov, V. N. (ed.). Metallofizika 22. Kiev, Naukova Dumka, 1968. (In Russian).

The metastable β-phase of $ZrCr_2$ proved to be stable at 800 to 1000°C after which it transforms into ϵ phase. The temperature of polymorphic transformation in $ZrCr_2$ compound was found at 1610 to 1620°C. (R.V.J.)

38990 EFFECT OF STRAIN RATE ON THE DISLOCATION SUBSTRUCTURE IN DEFORMED NIOBIUM SINGLE CRYSTALS. Edington, J. W. (Battelle Memorial Inst., Columbus, Ohio). pp 191-240 of Mechanical Behavior of Materials Under Dynamic Loads. Lindholm, Ulric S. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Symposium on Mechanical Behavior of Materials Under Dynamic Loads, San Antonio, Tex. See CONF-670986.

An investigation of the relations between mechanical properties and dislocation substructure in the strain rate range 10^{-4} to 10^4 sec^{-1} is described. The relations between lower yield stress τ_{yield} and strain rate ϵ follows two consecutive semilogarithmic relations of the form $\tau_{yield} = \alpha + \beta \log \epsilon$ with a break at a strain rate of approximately 10 sec^{-1}. The dislocation configurations produced by deformation in these two regions have been investigated at strain rates of 1.2×10^{-4} sec^{-1} and 1.5×10^3 sec^{-1} using transmission electron microscopy techniques. The relations between dislocation density, flow stress, and plastic strain have been determined and are discussed in terms of the dislocation structures observed. (auth)

38991 TEMPERATURE, HEATS, AND NONISOTHERMAL KINETICS OF THE TRANSFORMATIONS $\alpha \rightleftharpoons \beta$ AND $\beta \rightleftharpoons \gamma$ OF PLUTONIUM. Prunier, Claude; Radenac, Antoine; Roux, Claude; Rapin, Michel (CEA, Montrouge, France). Compt. Rend., Ser. C, 268: 1999-2002(June 9, 1969). (In French).

The temperatures and the heats of transformations $\alpha \rightarrow \beta$, $\beta \rightarrow \alpha$, $\beta \rightarrow \gamma$, and $\gamma \rightarrow \beta$ of plutonium were measured by differential enthalpic analysis. The kinetic interpretation of the thermograms obtained by comparing the ratios of the phases present at the times of transformation made it possible to establish two types of anisothermal kinetic curves, the one for the transformations $\alpha \rightarrow \beta$, $\beta \rightarrow \gamma$, and $\gamma \rightarrow \beta$, the other for the $\beta \rightarrow \alpha$ transformation. (tr-auth)

38992 THE PHYSICS OF METALS. 1. ELECTRONS. Ziman, J. M. (ed.). Cambridge, Eng., University Press, 1969. 433p. 90s.

A review by various authors is given under the following main headings: Electronic structure of metals; electronic structure−experimental results; metallic electrons in a magnetic field; transport properties−surface and size effects; ordinary transport properties of metals; electronic transport properties of liquid metals; experimental studies of structures of metals and alloys; transition metals−electronic structure of d-band role in crystalline and magnetic structures. (UK)

38993 SOLUBILITY OF NITROGEN IN MOLTEN Fe-V ALLOY. Wada, Harue; Gunji, Koki; Wada, Tsuguyasu (National Research Inst. for Metals, Tokyo). Nippon Kinzoku Gakkaishi, 33: 720-4(1969). (In Japanese).

The solubility of nitrogen in liquid V and Fe−V system has been measured in the temperature range from 1800 to 2200°C over wide composition range using the levitation melting method. The solubility of nitrogen in liquid V was very high and decreased with increasing temperature. In the Fe−V system, it was increased with increasing V content and decreased with increasing temperature. The departure of this system from Sieverts' law deserves attention because the activity coefficient was decreased with increasing nitrogen partial pressure. Values of the partial molar heat of solution ΔH_N of nitrogen and interaction coefficient $e_N^{(V)}$ were determined as functions of composition and of temperature, respectively, $\Delta \overline{H}_N$ in Fe−V system showed a higher negative value than that in the Fe−Cr system. Enthalpy coefficient $h_N^{(V)}$ was estimated as −2.26 kcal/mol. (auth)

38994 MOESSBAUER EFFECT STUDY OF SMALL ADDITIONAL Co ELEMENTS IN Cu-2 WT PERCENT Be ALLOY. Nasu, Saburo; Yoshida, Hiroyuki; Murakami, Yotaro (Kyoto Univ.). Nippon Kinzoku Gakkaishi, 33: 651-7(1969). (In Japanese).

In order to study the effect of small amounts of additional Co elements in Cu−2 wt % Be alloy, the ^{57}Fe Mössbauer effect has been investigated using the specimen in which ^{57}Co was doped. For the various aging sequences in the Cu−Be alloy, Mössbauer absorption spectra were measured at room temperature. All of the spectra obtained at room temperature show the superposition of paramagnetic and ferromagnetic components. From the paramagnetic single line, the isomer shift was estimated and it was found that the value did not greatly differ from that of ^{57}Fe in pure Cu. It is concluded that the paramagnetic Co component corresponds to the Co atoms dissolved in the Cu−Be alloy matrix. From the ferromagnetic 6-line components, the effective internal magnetic field of ^{57}Fe dissolved in the ferromagnetic Co component was estimated. The amount of the ferromagnetic Co component was also estimated. It was found that the ferromagnetic Co component constituted Co-rich particles; these ferromagnetic particles were also observed by thin foil electron microscopy. The role of Co atoms in aging of Cu−2 wt % Be alloy is discussed using the investigation results. (auth)

38995 THREE-DIMENSIONAL STRESS DISTRIBUTIONS AND DEGREE OF ANISOTROPY IN SOME HEXAGONAL METALS. Tang, R.; Kratochvil, J.; Conrad, H. (Univ. of Kentucky, Lexington). Scr. Met., 3: 485-8(July 1969).

The degree of anisotropy in Ti was investigated by calculating the elastic stress distributions about a single point force, and by calculating the anisotropy integrals in Ti crystals. Similar calculations were made for Zn, Mg, Zr, and Be. Results show that Be and Zn are highly anisotropic, whereas Ti, Zr, and Mg are nearly isotropic. (J.R.D.)

38996 SLIP ASYMMETRY IN MOLYBDENUM SINGLE CRYSTALS DEFORMED IN DIRECT SHEAR. Guiu, F. (Queen Mary Coll., London). Scr. Met., 3: 449-54(July 1969).

Shear tests revealed that there is in molybdenum an asymmetry for slip on {112} planes which explains the slip line pattern. The ratio of the critical shear stresses for the hard and soft {112} ⟨111⟩ systems is roughly >1.5. On the other hand the critical shear stress for slip on the hard {112} planes is at least twice the critical shear stress for slip on {110}. Slip on {110} planes is always observed, suggesting that, regardless of orientation, the yielding process involves elements of slip on the {110} ⟨111⟩ systems. This also explains why, for the stress system under discussion, the asymmetry of the yield and flow stress is much smaller than the asymmetry for slip on {112} planes. These results support the view that the magnitude of the yield stress in molybdenum is not determined directly by the asymmetry of slip on {112} planes. (auth)

38997 CALCULATION OF THERMODYNAMIC PROPERTIES FROM BINARY PHASE DIAGRAMS. Chiotti, P.; Simmons, M. F.; Kateley, J. A. (Ames Lab., Iowa). Nucl. Met., Met. Soc. AIME, 15: 659-88(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Basic thermodynamic relations for the description of binary phase boundaries are developed. Their application to the calculation of thermodynamic properties from phase boundary data and in checking the consistency of phase boundaries with known thermodynamic data are outlined. Thermodynamic properties cannot be calculated from phase boundary data alone. Data for the pure components and assumed empirical parametric relations can be employed to calculate useful information in favorable cases. The use of empirical relations in the correlation of known properties for binary systems is demonstrated and their application to the calculation of thermodynamic properties for the liquid phase in simple eutectic systems and for the solid phase in miscibility gap systems was investigated. (auth)

38998 THERMODYNAMIC ANALYSIS AND SYNTHESIS OF PHASE DIAGRAMS. Rudman, Peter S. (Israel Inst. of Tech., Haifa). Nucl. Met., Met. Soc. AIME, 15: 689-703(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

Computer calculations for synthesis, the deriving of phase diagrams from solution thermodynamic data, are described. Computer calculations for analysis, the deriving of solution thermodynamics from phase diagrams, are described. Consideration is limited to substantially disordered, binary systems. Examples of calculations for the Au–Ni, Al–Sn, and Ag–Au systems are presented. (auth)

38999 PREDICTION OF TERNARY THERMODYNAMIC PROPERTIES AND PHASE DIAGRAMS FROM BINARY DATA. Olson, N. J. (Ames Lab., Iowa); Toop, G. W. Nucl. Met., Met. Soc. AIME, 15: 705-24(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

With the use of binary data, excess molar free energy values and phase diagrams were calculated for a number of ternary systems. The equations used are considered to be rigorous for regular ternary systems and empirical for nonregular systems. The calculations are compared with experimental results where possible. These results are found to give reasonable estimates of ΔF^{xs} for the Pb–Sn–Cd, Sb–Cd–Pb, Bi–Cd–Sn, and Cd–Pb–Bi systems at 773°K, the $CaO–SiO_2–FeO$ system at 1873°K, and the Fe–Mn–Ni system at 1232°K. Phase diagrams were calculated for the Pb–Sn–Zn system at 926°K and the Ag–Pd–Cu system at 1000°K. (auth)

39000 CONTRIBUTION TO THE PLUTONIUM–MAGNESIUM PHASE DIAGRAM. Knoch, W.; Knighton, J. B.; Steunenberg, R. K. (Argonne National Lab., Ill.). Nucl. Met., Met. Soc. AIME, 15: 535-46(1969).

From Symposium on Reprocessing of Nuclear Fuels, Ames, Iowa. See CONF-690801.

The region of liquid immiscibility in the binary Pu–Mg system was determined by chemical analyses of the equilibrium liquid phases. The magnesium content of the plutonium-rich phase ranged from 0.49 at. % at 650°C to 2.22 at. % at 900°C, while the plutonium content of the magnesium-rich phase varied from 10.5 at. % at 523°C to 11.5 at. % at 900°C. The consolute temperature is estimated to be 1040 ± 10°C. Thermal analysis data are given for several solidus transition temperatures. The thermodynamic properties of liquid Pu–Mg alloys were estimated from the compositions of the equilibrium liquid phases assuming the alpha function $[\ln \gamma_i/(1-N_i)^2]$ to be a linear function of N_i. The estimated data are in agreement with previously reported thermodynamic data for dilute solutions of plutonium in liquid magnesium solutions. (auth)

39001 METALLOGRAPHIC STUDY OF THE BETA → ALPHA PHASE CHANGE IN PURE URANIUM. Drobnjak, Dj. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Ind. Chim. Belge, 32: Special No., (Vol. 2), 326-9(1967).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905(Vol.2).

Metallographic observations have been made on quenched and continuously cooled high purity uranium specimens. The results show that increase in the cooling rate modifies the alpha structure from equiaxed to irregular and acicular. Acicular structure is obtained only on rapid quenching, and it always coexists with irregular structure. There are two types of grain boundaries of irregular structure, irregular or nearly linear. These results lead to the conclusion that high-temperature reaction occurs by the normal diffusion-controlled process, while martensitic transformation takes place only on rapid quenching. It is tentatively suggested that the massive type of reaction is the transformation mechanism in the formation of the irregular structure. (auth)

39002 INFLUENCE OF TITANIUM, SULPHUR, AND OTHER ELEMENTS ON THE EUTECTIC SOLIDIFICATION OF Fe–C–Si ALLOYS. Lux, B. (Battelle Memorial Inst., Geneva). Mem. Sci. Rev. Met., 66: 347-74(May 1969). (In French).

Small additions of titanium and zirconium to commercial-grade cast iron have an influence similar to that of a vacuum melt treatment; this can be explained by partial elimination of elements such as sulfur especially oxygen, which have an effect on the growth of graphite lamellae and on the structure. (auth)

39003 STUDY OF THE INTRODUCTION OF URANIUM IN MOLTEN IRON, AND ITS BEHAVIOUR AT 1600°C WITH RESPECT TO VARIOUS NON-METALLIC ELEMENTS: OXYGEN, SULPHUR, CARBON, AND NITROGEN. Gatellier, C.; Olette, M. (Institut de Recherches de la Siderurgie Francaise, Saint-Germain-en-Laye, France). Mem. Sci. Rev. Met., 66: 407-23(May 1969). (In French).

Uranium has a marked affinity for oxygen. As regards sulfur, addition of uranium does not appreciably lower the total S content, but produces a fine dispersion of US particles of some few microns. Uranium does not seem to influence the solubility of nitrogen and carbon. (auth)

Radiation Effects

Refer also to abstract 40502.

39004 (AECL–3331) HIGH TEMPERATURE EMBRITTLEMENT OF METALS BY RARE GAS BUBBLES. Carpenter, G. J. C.; Nicholson, R. B. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr. 1969. 21p. (CONF-690620–1; SM–120/G–6). Dep. CFSTI. CAN $1.00.

From Symposium on Radiation Damage in Solids and Reactor Materials, Vienna, Austria.

There is considerable evidence that the high temperature embrittlement to which stainless steels and other cladding materials are prone is related to the presence of bubbles created from the helium introduced by (n,α) reactions. In order to study this phenomenon more closely, tensile specimens of a Cu–^{10}B alloy have been irradiated and tested at elevated temperatures after suitable annealing treatments to form bubbles. Since the ^{11}B atom has a very low neutron capture cross section, a Cu–^{11}B alloy served to provide control specimens. The results in specimens containing a low helium content (3 ppM atomic) showed that the helium bubbles promoted cavity formation at the grain boundaries during testing, and that the extent of cavitation was higher in a sample with larger bubbles. Larger quantities of gas (330 ppM atomic) caused a large reduction in the ductility at high temperatures (0.5–0.7 T_m where T_m = absolute melting temperature). Examination of the fractured specimens in the scanning electron microscope has confirmed that copious void formation at the grain boundaries was the main cause of fracture. Careful measurements of the sizes of bubbles at the grain boundaries show that the bubbles can act as void nuclei at smaller sizes than calculated using the simple theory. Comparison with data for stainless steels suggests a correlation between the density of bubbles at the grain boundaries and the degree of embrittlement. (auth)

39005 (BMI–1862, Sect.B) RADIATION EFFECTS ON FAST-REACTOR CLADDING AND STRUCTURAL MATERIALS. (Battelle Memorial Inst., Columbus, Ohio). 10p.

Summaries are presented on research efforts devoted to determining effects of neutrons on stainless steel, effects of Ni on radioinduced high-temperature embrittlement of cladding, development of methods for determining radioinduced mechanical property changes in cladding, and effects of variables such as irradiation temperature, dose, and flux spectrum on mechanical properties of cladding. (J.R.D.)

39006 (BNWL–1045) DISLOCATION-SUBSTRUCTURE INTERACTIONS IN IRRADIATED IRON AND STEEL. Smidt, F. A. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 73p. Dep. CFSTI.

The influence of radiation damage upon the mechanical properties of iron and steel are analyzed in terms of the substructure of defect aggregates produced by irradiation, the interaction of dislocations with the substructure, and the implications of these interactions on the macroscopic mechanical properties. An analysis of the most probable dislocation-defect interactions leads to the conclusion that the defects, while not influencing the short range forces controlling thermally activated processes in bcc metals, do interact strongly as long range forces affecting the athermal processes. An estimate of the increase in strength from observed defect sizes and densities indicates the increase in strength approaches that were predicted by the Orowan theory of precipitation hardening. Transmission electron microscopy observations, however, have shown that the defects are destroyed by moving dislocations. (auth)

39007 (BNWL–1058, pp 9.1-16) BASIC SWELLING STUDIES. Hann, C. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Research aimed at better definition of mechanisms involved and relations between burnup, temperature, pressure, and metallic structure of irradiated fissionable metals was continued during the period. Data are included on the irradiation status of encapsulated specimens of high-purity U; dilute U alloys with Al, Fe, and Si; Th, U alloys; and Si, U alloys. (J.R.D.)

39008 (BNWL-1058, pp 11.1-43) FAST REACTOR DOSIMETRY AND DAMAGE ANALYSIS. Nightingale, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Data from an EBR-II dosimetry experiment are presented. Activation data from the test reveal aspects of the neutron spectra in EBR II. Data on activity ratios indicate that EBR-II Core 31-F center spectrum remains essentially unmodified out to approximately row 4 in the reactor midplane. Progress is also reported in research on crystalline defects in irradiated reactor materials, and grain-boundary structure and energy in fcc gamma iron. (J.R.D.)

39009 (BNWL-1058, pp 12.1-79) IRRADIATION DAMAGE TO REACTOR METALS. Blackburn, L. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Progress is reported on operation of irradiation facilities for reactor metals. Data and information are included on radiation damage to stainless steels, Zr alloys, and heavy section pressure vessel steels. (J.R.D.)

39010 CREEP UNDER IRRADIATION OF TWO LOW CONTENT URANIUM ALLOYS. Englander, M.; de Montpreville, C. Thomas (CEN, Saclay, France). Colloq. Met., Commis. Energ. At. (Fr.) 11th, 1967, 29-37(1968). (In French).

From 11th Symposium on Metallurgy (Creep), Saclay, France. See CONF-670664.

Creep samples of natural uranium alloys have been irradiated at characteristic temperatures under a low tensile stress in an apparatus specially designed for use in the reactor EL 3. After several hundred hours irradiation, the increase in length of the samples was compared with that of a dummy sample placed outside the pile in creep conditions ressembling as much as possible those of the in-pile test. The measurements showed that the dimensional instability specifically connected with the test conditions either by the initial texture or by the structural evolution, made a relatively important contribution to the overall amount of deformation under an applied load. Taking into account this contribution, the amount of deformation under irradiation remains greater, for all the temperatures chosen, than that observed under non-irradiation conditions, the difference increasing inversely with temperature. (auth)

39011 APPLICATIONS OF FISSION FRAGMENT ETCH PIT TECHNIQUES IN URANIUM DETECTION. Elleman, Thomas S.; Kesler, Donald C. (North Carolina State Univ., Raleigh). Nucl. Appl., 7: 170-8(Aug. 1969).

Formation of fission fragment etch pits in glass was investigated with emphasis on the application of the method to the measurement of uranium distributions in solids and to low flux neutron dosimetry. The feasibility of using the method for determining uranium distributions in both small and large specimens was illustrated using specimens approximately 450 μm in diameter and large, uranium doped cesium iodide crystals. Upper and lower detection limits for uranium and neutron fluence were established for the glass slides employed. The purpose of the research was to illustrate the applicability of etch pit techniques to a range of problems in nuclear technology. (auth)

39012 CALCULATION ON THE MIGRATION OF FISSION GAS IN MATERIAL EXHIBITING PRECIPITATION AND RESOLUTION OF GAS ATOMS UNDER IRRADIATION. Speight, M. V. (Central Electricity Generating Board, Berkeley, Eng.). Nucl. Sci. Eng., 37: 180-5(Aug. 1969).

The influence of intragranular bubbles, acting as efficient trapping sites, on the migration of fission gas atoms in material under irradiation is assessed. It is considered that the bubbles are unstable due to the operation of an irradiation-induced resolution process tending to dissolve their enclosed gas. Treating an individual grain within the material as a sphere whose boundary behaves as a perfect sink, general expressions are derived for the intragranular concentrations of gas existing instantaneously within bubbles and in solution. It is shown that the relationships may be simplified for the range of irradiation times and conditions likely to be encountered in practice. Under these conditions, an expression is obtained for the quantity of gas released to the grain boundary, and this is compared with the analogous expression derived previously by Booth for the case where there are no intragranular traps. The fact that the resolution process through its effects on bubbles at the grain boundary will return some gas to the matrix and in so doing destroy the property of perfect-sink behavior is later considered. By an approximate method the appropriate modification to the formula describing the quantity of gas released to the boundary is deduced. This final expression, including the complete effects of intragranular trapping and irradiation-induced resolution on gas migration, may provide the basis on which to calculate the amount of gas which is eventually released external to the material from regions where intergranular bubbles grow so large that they interlink. (auth)

39013 FAST-NEUTRON EFFECTS ON TYPE-304 STAINLESS STEEL. Carlander, R.; Harkness, S. D.; Yaggee, F. L. (Argonne National Lab., Ill.). Nucl. Appl. Technol., 7: 67-75 (July 1969).

Tensile properties of irradiated Type-304 stainless steel have been measured. These results have been correlated with microstructural observations obtained by optical and transmission electron microscopy techniques. The material studied was irradiated in a fast neutron environment to a peak exposure of 4.8×10^{22} n/cm^2 at temperatures ranging from 371 to 463°C in the EBR-II reactor. True yield stresses were observed to increase and true uniform strains decrease with both increasing neutron exposure and decreasing irradiation temperature for test temperatures below 750°C. At 750°C no increases in true yield stresses over control values were noted while sharp decreases in true uniform strains were observed. It is suggested that some annealing of the microstructure occurs at this elevated temperature, allowing helium to be accumulated at grain boundaries. Microstructural examination by transmission electron microscopy revealed homogeneous distributions of polyhedral voids and Frank dislocation loops. Neither defect was observed to form on grain boundaries. It is suggested that the dislocation loop formation is primarily responsible for the increased strength of the irradiated material. Immersion density measurements are included. These results indicate that the peak void formation did not occur at the maximum flux position, thus indicating the importance of temperature to the phenomenon. (auth)

39014 EFFECTS OF GAMMA RADIATION ON THE BEHAVIOR OF NICKEL AND CADMIUM ELECTRODES. Argue, G. R. (Atomics International, Canoga Park, Calif.); Recht, H. L.; Arcand, G. M. Contract NAS7-100. J. Electrochem. Soc., 116: 1164-6 (Aug. 1969).

Studies were made on the effects of γ radiation on Cd and Ni electrodes in alkaline solutions without the possible interferences from other materials, such as separators, cases, etc., in a complete battery. The results showed that the electrodes lost weighable amounts of material (>0.2 mg) whenever the total radiation dose was 5.8×10^6 Rads or more. Visual indication of disintegration, appearing as a turbidity in the electrolyte solution, began at 1.4×10^6 Rads. Losses in comparison cells in the water bath were negligible. Cd electrodes lost capacity when cycled during irradiations of 8×10^7 Rads or more. Capacity losses were observed only when the cells were cycled. The effects of gas evolution may partly explain the permanent loss of Cd electrode capacity. (P.C.H.)

Ceramics and Cermets

Refer also to abstracts 38073, 38916–38919, 38921, and 38922.

39015 (BMI-1862) PROGRESS ON DEVELOPMENT OF MATERIALS AND TECHNOLOGY FOR ADVANCED REACTORS, JANUARY-MARCH 1969. Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). Apr. 1969. Contract W-7405-eng-92. 101p. Dep. CFSTI.

Progress on materials development is summarized in three sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 39005, 39016, and 39038.

39016 (BMI-1862, Sect.A) URANIUM-PLUTONIUM NITRIDE FUELS FOR LMFBR APPLICATIONS. (Battelle Memorial Inst., Columbus, Ohio). 60p.

Progress is summarized on developments associated with sintering and vaporization of PUN and PUN-UN fuels, properties of the system UO_2-U_3N_{3+x}, compatibility of PUN-UN with cladding materials and reactor coolants, analysis of capsule-sodium bonds for O, fabrication of clad $(U_{0.8}\ Pu_{0.2})N$ pellets, thermal irradiation of nitride fuels, EBR-II fuel pin cladding, preparation of irradiation capsules, and preparation for PUN-UN fuel TREAT testing. (J.R.D.)

39017 CHEMISTRY OF HIGH-TEMPERATURE MATERIALS. Proceedings of the Second All-Union Conference on the High-Temperature Chemistry of Oxides, Held in Leningrad, November 26-29, 1965. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969. 242p. (CONF-651160).

Translated from Khimiya Vysokotemperaturnykh Materialov by Cabell B. Finch.

Individual abstracts were prepared for 15 of the 40 papers in-

cluded in this proceedings. The remaining 25 papers were not in scope for NSA. (L.M.T.)

For abstracts of individual papers see: 37955, 39025–39027, 39050–39057, and 39565–39567.

Corrosion and Erosion

39018 ON THE CORROSION OF FIRE-RESISTANT CERAMIC MATERIALS IN A PLASMA OF COMBUSTION GASES. Hoch, P.; Masek, M. (Akimov Inst. for Material Protection, Prague). Werkst. Korros., 19: 1026-31(Dec. 1968). (In German).

The corrosive and erosive effects of air, CO_2, H_2O, and N_2 plasmas on some ceramic materials were investigated. The plasmas were developed at 2000 V and 22.9 MHz. The acceleration of the electrically charged plasma particles reached 8500 cm sec^{-2}, and temperatures as high as 4050°C were attained. The ionization products are described. Samples of Al_2O_3, MgO, ZrO_2 stabilized with 6% CaO, and spinel were inserted in a combustion gas plasma at about 3000°C. Mixtures of Al_2O_3 and P_2O_5 were also studied. Loss of weight was observed from 2% at 20 min for ZrO_2 at 9% for the spinel, and up to 30% for the mixtures, for tests in air. Tests in CO_2 caused changes from 4% gain in 20 min for ZrO_2 to 25% loss for Al_2O_3; the mixtures ranged from 8% gain to 52% loss. In water Al_2O_3 and MgO gained a few % in weight after 20 min; the mixtures lost from 4% to 72% weight. In N_2 gains of 8% were noted for Al_2O_3 and spinel, and losses from 4% to 52% for the mixtures. The most stable mixture in each case was KTZ, a mixture with a mole-ratio $Al_2O_3 : P_2O_5$ in binder of 0.5; mole ratio in cement, 70% ZrO_2 stabilized, 10% Zr_2SiO_4, 20% binder; binder content, 20%. Temperature stability extended to above 1850°C; density, 3.5 to 4.0; water uptake, 20%. (BBB)

Preparation and Fabrication

Refer also to abstracts 38192, 38939, 38950, and 38953.

39019 (EUR-4273) TECHNOLOGICAL IMPROVEMENT IN THE FABRICATION OF CAST URANIUM CARBIDE RODS. Final Report. Himmelstein, P.; Kuehn, H.; Pfahls, O.; Lucas, R. (Nuklear-Chemie und -Metallurgie G.m.b.H., Wolfgang bei Hanau (West Germany)). June 1969. Contract 246-66-1-ORGD. 50p. (In German). Dep.

Development of a process for economic fabrication of uranium monocarbide fuel for ORGEL is discussed. Work began with studies on the fabrication of uranium carbide from uranium dioxide and graphite powder. At the same time preliminary smelting tests were performed with small arc furnaces. In the next section of the program the most favorable powders for the solid-state reaction together with the optimum conditions for the reaction were determined. Development and construction of arc furnaces on a technical scale were associated with studies on suitable crucible and electrode materials. After fairly large-scale smelting plants had been commissioned, comprehensive studies were initiated on the influence of smelting conditions on the quality of uranium carbide rods. The experience gained with smaller production series led to a modification of the process of fabricating uranium carbide pellets. In arc smelting it was found that despite certain technical difficulties vacuum smelting was more suitable than shielding-gas smelting for the preparation of uranium carbide on a relatively large scale with a very low impurity fraction. Since the ORGEL design requires uranium carbide rods to be fabricated with a well-defined surface area, all-round grinding of the rods is necessary. This is also the only way of dishing the rods. An account is given of the techniques used in cylindrical, cut-off, face and dishing grinding. Factors affecting the profitability of the process are discussed. (auth)

39020 (JUL-583-RW) INVESTIGATION OF THE PRODUCTION OF SPHERICAL FUEL PARTICLES BY A SOL-GEL PROCESS. Foerthmann, R.; Naoumidis, A.; Nickel, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Mar. 1969. 41p. (In German). Dep.

By application of the internal gelation in the preparation of spherical gel particles from a suitable UO_2-sol it was possible to obtain high-density UO_2 microspheres with diameters up to 1000 μm. The procedure for sol preparation, gelation of sol to spherical particles, drying, and sintering are described along with the equipment used. This process is also suitable for the preparation of $(U,Th)O_2$- and ThO_2 microspheres. The sols and gels prepared are characterized by chemical analysis, measurement of viscosity, determination of crystallite size from x-ray linebroadening, and electron-microscopy. The properties of kernels such as diameter, density, and porosity are described as a function of the conditions of gelation and sintering. The process is not only suitable for the preparation of oxide fuel kernels, but also for carbides. In this connection the conditions for the formation of one-phase U(C,N) kernels and those for the preparation of UC_2 kernels are described. (auth)

39021 PRODUCTION OF MICROSPHERES. (to W. R. Grace and Co.). British Patent 1,158,742. July 16, 1969. Priority date Nov. 3, 1965, United States.

A process is described for preparation of metal oxide aquasols, particularly those of the actinides, in which droplets of the aquasol form in ammoniated liquid media in which water has low solubility. The droplets are kept in contact with the liquid medium and conditions are maintained such that the droplets gel and water is extracted from them by the liquid medium. Under these conditions the gel beads solidify into microspheres. The liquid medium may be hexanol, and ethyl hexanol, or an ethyl butanol. (J.R.D.)

39022 PREPARATION OF METAL OXIDE MICROSPHERES. Flack, Herbert Paul; Sanchez, Moises Gali; Lamberth, Charles Thomas (to W. R. Grace and Co.). British Patent 1,159,280. July 23, 1969. Priority date Aug. 2, 1966, United States.

A process for preparing metal oxide microspheres is described which comprises forming droplets of an aqueous feed having a concentration of from 0.01 g/l to saturation of dissolved salt of U^{+4}, $(UO_2)^{+2}$, Th^{+4}, $(PuO_2)^{+2}$, Pu^{+4}, $(ZrO)^{+2}$, Be^{+2}, Y^{+3} or a lanthanide, or a mixture of such salts, in a solvent in which water has low solubility and which contains ammonia in an amount sufficient to make the pH of the solvent 8 to 13.5. The droplets are kept in contact with the solvent; the process being conducted under such conditions that the droplets gel and have water extracted from them by the solvent. They are thus solidified to microspheres. The solvent may be a hexanol, ethyl hexanol, or ethyl butanol. (J.R.D.)

39023 A METHOD FOR THE PRODUCTION OF SPHERICAL PARTICLES (CASE 1). Knotik, Karl; Koss, Peter; Markl, Heinz (to Osterreichische Studiengesellschaft fuer Atomenergie GesmbH). British Patent 1,157,012. July 2, 1969. Priority date July 8, 1965, Austria.

A method is described for production of spheroidal metal salt particles using metals in groups IVA, VA, or VIA of the periodic table or metals such a U, Th, or Pu. The salt is melted then sprayed or allowed to drop-cool solidify. The salts thus formed can be converted to other compounds such as carbides, nitrides, oxides, sulfides, borides, or silicides by reactions with suitable gases or liquid reagents. (J.R.D.)

39024 PYROLYTIC CARBON STRUCTURES AND PROCESS FOR MAKING SAME. (to Gulf General Atomic Inc.). British Patent 1,157,705. July 9, 1969. Priority date Oct. 22, 1965, United States.

Processes for deposition of pyrolytic carbon on shaped substrates used at high temperatures and under fast neutron irradiation are described. An improved pyrolytic carbon structure is characterized having good mechanical strength, excellent high temperature dimensional stability, and resistance to neutron damage. The material has an isotropic crystalline structure and a density of at least 1.8 g/cc. (J.R.D.)

39025 KINETICS AND DEFORMATION MECHANISM OF HIGHLY REFRACTORY OXIDES AND THEIR COMPOUNDS DURING COMPONENT FORMATION. Orlova, I. G. pp 179-87 of Chemistry of High-Temperature Materials. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969.

From 2nd All-Union Conference on the High-Temperature Chemistry of Oxides, Leningrad, USSR. See CONF-651160.

The general kinetic laws and deformation mechanics in the sintering of the highly refractory oxides Al_2O_3, MgO, and ZrO_2 and the compound $MgO \cdot Al_2O_3$ were studied experimentally. It was found that the introduction of small (up to 1%) amounts of additives (spinel additive, forsterite, talc, magnesium titanate, zirconium dioxide, zinc oxide, silicon dioxide, iron oxide, aluminum oxide, and titanium dioxide) to the base oxide can reduce the threshold deformation temperature, and generally increases both the deformation in the irregular stage and increase the rate of uniform deformation. The introduction of large (1 to 2 mol%) amounts of additives forming high-concentration solid solutions (e.g., of CaO, MgO, Y_2O_3, CeO additives to ZrO_2) can reduce deformation either starting at the introduction or after some period of activation of the self-diffusion process. It was concluded that the deformation of oxide materials in the absence of a liquid phase (within threshold stress limits) obeys the law of diffusional-viscous flow and is dependent on the volume diffusion of vacancies. (D.H.M.)

39026 KINETICS AND MECHANISM OF SINTERING AND RECRYSTALLIZATION IN REFRACTORY OXIDES AND THEIR COMPOUNDS. Degtyareva, E. V. pp 188-95 of Chemistry of High-Temperature Materials. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969.

From 2nd All-Union Conference on the High-Temperature Chemistry of Oxides, Leningrad, USSR. See CONF-651160.

The shrinkage kinetics on sintering the refractory oxides, Al_2O_3, MgO, and ZrO_2, and the compound $MgO-Al_2O_3$ were investigated. The study was performed at temperatures up to 1500°C (where sintering occurs by removal of open porosity) and at temperatures of 1600 to 1750°C (where sintering occurs by removal of closed porosity). The effect of pressure on the sintering of the oxides was also studied. The interrelation between sintering and recrystallization was examined through the kinetics of sintering by heterodiffusion (for solid-solution formation) and by reactive diffusion (for compound formation). Results show that the formation of small amounts of solid solutions, which increase the amount of defects in the crystal lattice, facilitates an increased degree of sintering in the basic oxide; however, further increase in the amount of additive lends to an intensive growth of solid-solution formation by the process of heterodiffusion. Reactive diffusion, which does not alter the kinetics, sharply reduce the degree of sintering in refractory oxides and their compounds. The application of small external loads with hydrostatic pressure sharply increase the degree of refractory oxide sintering, while not changing the character of the shrinkage kinetics. (D.H.M.)

39027 CRYSTALLIZATION OF MELTS IN THE $BeO-Al_2O_3-SiO_2$ SYSTEM. Dmitriev, I. A.; Semin, E. G. pp 135-7 of Chemistry of High-Temperature Materials. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969.

From 2nd All-Union Conference on the High-Temperature Chemistry of Oxides, Leningrad, USSR. See CONF-651160.

Melts of the $BeO-Al_2O_3-SiO_2$ system corresponding in composition to the mineral beryl were studied. New glass-crystalline materials based on this system were obtained. The behavior of oxides in the system during crystallization of beryl glass was shown. Crystallization of beryl melts catalyzed by transition metal oxides was studied. (auth)

39028 IMPROVEMENTS IN OR RELATING TO PROCESSES INVOLVING THE PYROLYTIC DEPOSITION OF CARBON OR OTHER SUBSTANCES FROM A GAS OR VAPOUR. Mayr, Kurt August Manfred; Flamm, Hermann Jakob (to United Kingdom Atomic Energy Authority). British Patent 1,158,637. July 16, 1969. Filed Aug. 25, 1966.

Reference is made to processes for the production of coated particle nuclear fuels. A suitable oxidizing agent is introduced into the high temperature apparatus through an injection orifice along with the process gas in order to initiate an exothermic zone adjacent to the orifice, thus lessening the risk of soot building up on the apparatus walls or blocking the orifice, as well as contributing to raising the temperature in the apparatus. Alternatively, the oxidizing agent can be introduced by other routes with the object of obtaining exothermic heat at other parts of the apparatus. The oxidizing agent is preferably CO_2, O_2, air or water vapor. A high concentration of coating agent may be used in the process gases, giving high deposition rates, and very high coating temperatures may be achieved. A special nozzle construction around the orifice may be necessary to avoid burning back. It is preferable to employ a substance which exerts its oxidizing action only at the high temperature obtaining at the orifice. In the pyrolytic deposition of carbon on particles in a fluidized bed it is preferable to add CO_2 as oxidizing agent; this has the advantage of increasing the partial pressure of CO and suppressing carbide formation. Examples of application are given. (UK)

39029 PROPERTIES OF VARIOUS BeO POWDERS AND THEIR SINTERABILITY. Hattori, Takeo; Suzuki, Hiroshige (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 90, 91-104(Mar. 1969).

It was found by investigation that the most sinterable BeO powder is obtained when the aggregates are loosened by crushing after the sulfate is thermally decomposed and calcined at an adequate temperature. The shrinkage owing to initial sintering of the BeO powder proceeds linearly against time. This linearity of the shrinkage is characteristic of the process. (NSA of Japan)

39030 PROCESS FOR THE PRODUCTION OF NUCLEAR FUEL. (to EURATOM). French Patent 1,447,920. Filed Jan. 13, 1964.

A process is described for the production of nuclear fuel comprising the preparation of particles containing at least one oxide of a nuclear fuel metal, coating the particles with pyrolytic carbon by means of a process which includes fluidizing the particles in a fluidized bed with an inert gas, passing a stream of hydrocarbon gas through the bed, heating the bed to a temperature high enough to ensure that an initial coating of pyrolytic carbon is deposited on the particles but below that at which any appreciable reaction between the oxides and the carbon is provoked, and then applying a similar coating at a higher temperature. Preferably the initial coating is applied by passing propane through the fluidized bed at a temperature of 1300°C, and the second coating is applied by passing methane through the bed at a temperature of 1700°C. (NPO)

39031 PROCESS FOR THE PREPARATION OF SPHERICAL PARTICLES OF NUCLEAR FUEL MATERIAL. (to EURATOM). French Patent 1,484,632. Filed Aug. 26, 1965.

The preparation of spherical particles of nuclear fuel material by the sol-gel process is described. Hydrophilic carbon is added to a solution of a nitrate of a nuclear fuel metal. The hydroxide of the metal is precipitated by adding ammonia, the carbon particles being entrained in the hydroxide. After washing the precipitate is peptized to form a sol which is added drop by drop to an organic dispersing medium. Preferably the precipitate is washed with nitric acid so as to establish a metal : nitrate ratio of 20 : 1 and is peptized by means of uranyl nitrate. In a modification the hydrophilic carbon is suspended in the peptizing solution, which is acidified with nitric acid. (NPO)

39032 PROCESS FOR THE PREPARATION OF SPHERICAL OR SPHEROIDAL PARTICLES OF NUCLEAR FUEL MATERIAL. (to EURATOM). French Patent 1,407,496. Filed Sept. 11, 1964.

A process is described for the preparation of spherical or spheroidal particles of nuclear fuel material in which a thick paste is granulated by means of a sieve, the paste consisting of either one or more of the powders to be converted into particles and a binder which is capable of assuring the required consistency in the paste for the granulation operation and the binding of the powder grains during the spheroidization process. The binder comprises at least one polymerizable monomer, preferably a monomer of which the polymerization is catalyzed by one of the components of the fuel powder e.g., finely-divided carbon. In an example the powder consists of 230 g of Th, 20 g of UC and 30 g of graphite, and the binder consists of 32 cc of acrylonitrile. (NPO)

39033 CONVERSION OF UF_6 INTO BASE MATERIALS FOR THE FABRICATION OF FUEL ELEMENTS. De Troy, A.; Nicolai, J.; Mortelmans, H. Ind. Chim. Belge, 32: Special No., (Vol. 1), 727-9(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

A review is presented of different methods of production of base materials used in the fabrication of fuel elements for nuclear reactors: oxides, carbides, metals, alloys, etc. The conversion of UF_6 to a powdered UO_2 ceramic for use as fuel elements in the Ardennes plant is described. (tr-auth)

39034 INFLUENCE OF THE PHYSICAL CHARACTERISTICS OF URANIUM OXIDE ON ITS BEHAVIOR ON SINTERING. Potdevin, H. (Metallurgie et Mecanique Nucleaires, Dessel, Belg.). Ind. Chim. Belge, 32: Special No., (Vol. 1), 771-4(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

In the fuel elements for nuclear reactors intended for the production of electricity, the fissile material is, in a number of cases (PWR, BWR, AGR), in the form of uranium oxide pellets. These pellets are produced by sintering under hydrogen starting with powdered uranium dioxide obtained by the conversion of the hexafluoride. The irregular behavior of the powder on sintering has often caused serious difficulties. Since it is difficult to foresee, recourse is taken to testing a sample by sintering. On the basis of numerous tests it is possible to attribute a fundamental role to a knowledge of the total specific surface of the powder. This characteristic can be measured easily thanks to a procedure based on the adsorption of nitrogen (the BET method). Thus this characteristic can become the sole physical criterion for the acceptance of uranium dioxide powders. Tests show that there exists for each type of powder an ideal total specific surface carrying with it a maximum density for the pellet after sintering. (tr-auth)

39035 VIBRATION COMPACTED UO_2 FUEL. III. EFFECTS OF RANDOM WAVE VIBRATION ON COMPACTED DENSITY. Hirose, Yasuo (Hitachi, Ltd., Ibaraki, Japan). J. Nucl. Sci. Technol. (Tokyo), 6: 351-8(July 1969).

Random wave motion of characteristics and intensities measured in terms of frequency and normalized acceleration has been applied to vibratory compaction of UO_2 powder in a metal tube, and the results are compared with those obtained by other methods of vibration. Densification proceeds rather slowly but

steadily with random wave compaction, which moreover does not appear to produce the particle segregation on the top layers of the UO_2 powder experienced with sinusoidal and other forms of wave. Consequently, the densities obtained are consistently higher than by other methods of vibration at the same normalized acceleration level. Acceleration peaks, and not average values, appear to be the predominant factor determining the efficacy of vibration in particle compaction, while displacement peaks contribute little either to compaction or to particle segregation. (auth)

39036 PROCESS FOR DISINTEGRATING GRAPHITE BODIES. Knotik, Karl; Leichter, Peter; Wagner, Harald (to Osterreichische Studiengesellschaft fuer Atomenergie). U. S. Patent 3,453,091. Priority date Apr. 12, 1966, Austria.

A method is described for the recovery of nuclear fuel particles from graphite bodies in which the particles are embedded. According to the process, the graphite bodies are subjected to the action of oxidizing acids or their salts, whereby the graphite bodies are disintegrated into graphite powder and fuel particles. The graphite powder and the fuel particles are then separated from each other. A number of oxidizing acids such as peroxy acids or fuming nitric acid are specifically disclosed. (Offic. Gaz.)

39037 METHOD OF AND APPARATUS FOR THE TREATMENT OF GRAPHITE COATED PARTICLES FOR NUCLEAR REACTORS AND THE LIKE. Schulten, Rudolf; Bohn, Thomas; Hecker, Rudolf; Baurmann, Karl-Wilhelm (to Kernforschungsanlage Julich des Landes Nordrhein-Westfalen-e.V.). U. S. Patent 3,453,090. Priority date Apr. 23, 1966, Germany.

A method of treating coated-particle nuclear-fuel and breeder elements is described in which the graphite-coated particles, having a particle size of 200 to 800 microns and cores of uranium carbide, thorium carbide, plutonium, uranium oxide, thorium oxide and mixtures thereof, are subjected to treatment with cesium or potassium vapor or liquid in a rotating drum or vortex reactor at a temperature between 300°C and 1000°C to destroy the graphite coating and any graphite bodies in which the particles are received, and thereafter the particle cores, stripped from their graphite shell, are recovered from the graphite residue for further coating or treatment. (Offic. Gaz.)

Properties Evaluations

Refer also to abstracts 38146, 38147, 38173, 38959, 38972, 39061, 39566, and 39068.

39038 (BMI-1862, Sect.C) CREEP OF REACTOR FUEL MATERIALS. (Battelle Memorial Inst., Columbus, Ohio). 30p.

Research on high-temperature creep of fuels for liquid metal fast breeder reactors is described. Progress is reported on design and operation of in-pile creep capsules, fabrication of UO_2 and PuO_2-UO_2 specimens for preirradiation creep testing, and on in-pile compressive creep testing. (J.R.D.)

39039 (CEA-N-883) EVALUATION OF THE COEFFICIENT OF CHEMICAL DIFFUSION OF OXYGEN IN URANIUM DIOXIDE ABOVE STOICHIOMETRY. Marin, Jean-Francois (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar. 1968. 12p. (In French). Dep.

Studies were made on the kinetics of reduction and the observation of gradients in the ratio O/U in the fritted samples of uranium oxide above stoichiometry ($UO_{2.00}$) during reduction by hydrogen at 500°C. The results were interpreted by a mechanism of oxygen diffusion outside the network of over-stoichiometric dioxide, the ratio O/U varying, in the course of the reduction, in a continuous fashion between O/U = 2.00 at the surface and O/U = 2 + x in the inner part of the sample. (tr-auth)

39040 (KFK-tr-281) HEAT OF FORMATION AND ENTROPY OF FORMATION OF PLUTONIUM CARBIDE. Achachinskij, V. V. Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, Ger.), from Panel Meeting on the Thermodynamic Properties of Uranium Carbides and Plutonium Carbides, Vienna, Austria, September 9-13, 1968. 13p. (In German). (CONF-680960-1). Dep.

The heats of formation for $PuC_{0.87}$, Pu_2C_3, and PuC_2 were calculated and compared with experimental data. The probable entropy values are also given. (M.C.G.)

39041 (LA-4171) CMF-13 RESEARCH ON CARBON AND GRAPHITE. Report No. 9. Summary of Progress, February 1-April 30, 1969. Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). May 13, 1969. Contract W-7405-eng-36. 31p. Dep. CFSTI.

Research aimed at increased understanding of carbon and graphite is reported. Microstructures are being studied to characterize natural, commercial, and experimental graphites. Physical and mechanical properties are being measured and the results correlated with formulation, treatment, and environmental variables. Research results are reported on Santa Maria coke, graphite filler materials, graphite binders, mechanical properties of compacted graphite, solid raw materials, and polycrystalline graphite. (J.R.D.)

39042 (SC-DC-69-1892) HELIUM RELEASE DATA FOR $^{238}PuO_2$ MICROSPHERES. Stark, W. A. Jr. (Sandia Labs., Albuquerque, N. Mex.). July 1969. 173p. Dep. CFSTI.

The results of mass spectrometric analyses of the helium gas released during annealing of production grade, plasma torch fused $^{238}PuO_2$ microspheres are presented for several fuel samples at varying temperatures. Each data set consists of a temperature-time curve, a release rate-time curve, a fractional total release-time curve, and a diffusion coefficient-time curve. The fractional release curve was obtained by integrating the release rate-time curve, and the diffusion coefficient was calculated from the fractional release curve assuming a simple diffusion model with a time-varying diffusion coefficient. (auth)

39043 (WAPD-TM-843) SURFACE DIFFUSION MEASUREMENTS IN ThO_2, UO_2, AND ThO_2-UO_2 (LWBR DEVELOPMENT PROGRAM). Berman, R. M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). July 1969. Contract AT(11-1)-Gen-14. 37p. Dep. CFSTI.

Diffusion in UO_2 and ThO_2-UO_2 mixtures were determined after heat treatments at 1510 to 2500°C by use of interference microscope. Photomicrographs were made of several different fields on each sample surface, and approximately 50 groove width measurements were made on these photographs for surface diffusion coefficient determination. An analysis of results is included. (J.R.D.)

39044 IMPROVEMENTS IN OR RELATING TO PRE-STRESSING OF CONCRETE PRESSURE VESSELS. Taylor, Reginald Sidney; Burrow, Reginald Edwin Downton; Mason, John Morton; Portas, John Richard; Thomas, William David (to Taylor Woodrow Construction Ltd.). British Patent 1,157,494. July 9, 1969. Filed Aug. 12, 1966.

Reference is made to apparatus for the circumferential stressing of cylindrical concrete pressure vessels which may be employed for nuclear reactors, or for the storage of gas or other material under pressure. The apparatus comprises a platform or staging surrounding the vessel, capable of being moved vertically with regard to the vessel and positively located in any selected position, together with a mobile unit supported on the platform for movement around the pressure vessel and equipped to hold a supply of wire, together with tensioning means. Movement of the mobile unit results in winding the wire around the pressure vessel, and the tensioning means maintains a predetermined tension in the wire. Various alternative tensioning means, various forms of mobile units, and platform or staging units are described. (UK)

39045 RECRYSTALLISATION OF MACHINED SURFACES OF BERYLLIUM OXIDE. Veevers, K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Aust. Ceram. Soc., 5: 16-20(May 1969).

The effect of machining and annealing on the mechanical properties of polycrystalline beryllium oxide were studied. Machining introduced cracks into the surface of bend test specimens and thus reduced the strength. Subsequent annealing for one hour in the range of 500 to 1500°C reduced the number of cracks and the strength was restored. When the given size exceeded 5 μm no recovery of strength was achieved for the relatively short annealing times used. The addition of 0.2% MgO affected the annealing characteristics of the BeO above 700°C. Electron microscopy showed that during annealing recrystallization occurred in regions which had been plastically deformed during machining. (auth)

39046 COMPUTATION OF CREEP EFFECTS IN PRE-STRESSED CONCRETE PRESSURE VESSELS USING DYNAMIC RELAXATION. Cederberg, H. (Swedish State Power Board, Fack, Sweden); David, M. Nucl. Eng. Design, 9: 439-48(Apr. 1969).

A method developed for time dependent stress analysis of prestressed concrete pressure vessels is described. Different creep functions for concrete are discussed at first in order to select the best basis for the computation. The full solution is obtained in a step-by-step process. The time is divided into short intervals during which the stresses are supposed to remain constant. According to this assumption the creep strain increments are calcu-

lated after each time interval and then the incompatibility is corrected by an elastic solution. The complete previous stress history which has to be known for the computation of the new step is stored on the tape. This enables the free choice of the creep function as well as of the length of all time intervals. The so-called dynamic relaxation method is used for the elastic solution at any stage. The application of dynamic relaxation for the purpose of time-dependent stress analysis is also presented. The structure of the computer program compiled in ALGOL language is briefly discussed. Results of the computation for a cylindrical vessel subjected to the steady thermal gradient are presented. (auth)

39047 TIME-DEPENDENT STRESSES IN A LONG THICK CYLINDRICAL PRESTRESSED CONCRETE VESSEL SUBJECTED TO SUSTAINED TEMPERATURE CROSSFALL. England, G. L. (King's Coll., London); Phok, M. Nucl. Eng. Design, 9: 488-95 (Apr. 1969).

The effect of differential thermal creep of concrete is discussed in relation to the time-dependent stresses in a thick cylindrical prestressed concrete vessel subjected to a sustained radial temperature distribution and internal pressure. Two methods of analysis, capable of estimating these stresses are described and the solution to a worked example is included. It is concluded that slow heating of a vessel is desirable, if stresses are to be kept within reasonable limits, and that the long-term effect of creep is to give rise to undesirable reversals of stress on cooling. Using the rate of creep strain laws to calculate stress changes during the initial heating period and the steady-state stress theory for a long-term solution, it is possible to carry out a safe design for a vessel structure without performing a complete historical analysis. (auth)

Structure and Phase Studies

Refer also to abstracts 37955, 38987, 39002, 39003, and 39041.

39048 (ALI-3411-3) INVESTIGATION OF THE MECHANICAL PROPERTIES OF TRANSITION METAL CARBIDES AND BORIDES. Final Report. (Little (Arthur D.) Inc., Cambridge, Mass.). Oct. 14, 1967. Contract AT(30-1)-3411. 64p. Dep. CFSTI.

Results of a program to examine the high-temperature deformation mechanisms of single-crystal zirconium carbide and zirconium diboride are presented. Experiments were conducted using large, high purity, well characterized single crystals to determine the slip direction, active slip planes, the critical resolved shear stress as a function of temperature, and the steady state creep rate as a function of stress and temperature. (J.R.D.)

39049 CRYSTAL STRUCTURE OF THE COMPOUND $CeNi_{3.6}Si_{2.4}$ AND RELATED COMPOUNDS. Bodak, O. I.; Gladyshevskii, E. I. Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 5, 452-5(May 1969). (In Ukrainian).

The crystal structure of $CeNi_{3.6}Si_{2.4}$ was determined by means of single crystal x-ray analysis. The structure is tetragonal with $a = 9.799 \pm 0.005$ Å, $c = 6.249 \pm 0.005$ Å space group $I4_1/amd$; 4Ce in 4(a), 2.4 Ni + 1.6Si in 4(b), 8Si in 8(d), 32Ni in 32(i) with x = 0.1234, y = 0.0494, z = 0.1778 ($BaCd_{11}$ type superstructure). The existence of the isostructural compounds in the systems R–Ni–Si (R–La, Pr, Nd, Sm, Eu), R–Co–Si (R–Nd, Sm, Eu, Gd, Tb, Dy, Ho, Y) and Nd–Cu–Al was established. (auth)

39050 INTERACTION OF SCANDIUM OXIDE WITH OXIDES OF ELEMENTS OF THE TITANIUM SUBGROUP. Komissarova, L. N.; Pokrovskii, B. I.; Spiridonov, F. M. pp 104-7 of Chemistry of High-Temperature Materials. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969.

From 2nd All-Union Conference on the High-Temperature Chemistry of Oxides, Leningrad, USSR. See CONF-651160.

In the $Sc_2O_3-TiO_2$ system, two types of compounds are formed: a 3:2 composition ($3TiO_2 \cdot 2Sc_2O_3$) and a 2:3 composition ($2TiO_2 \cdot 3Sc_2O_3$). A study of the $Sc_2O_3-ZrO_2$ system showed that the following phases occur with an increase of Sc_2O_3 concentration: α-phase, β-phase, γ-phase, and δ-phase. The study did not give a conclusive picture of the phase equilibrium; there is no indication whether there occurs a 2-phase region or a continuous transition from one form to the other. In the $Sc_2O_3-HfO_2$ system, phases characterized by distribution similar to the β and γ phases of the Zr system were found. A continuous transition was observed between these phases, and a phase was found corresponding to the 2:1 composition ($Sc_2Hf_2O_7$), whose stoichiometry corresponds to the composition of a pyrochlore-type compound. It was previously reported that the interaction of Sc_2O_3 with ThO_2 resulted in an insignificant solubility of Sc_2O_3 in ThO_2 approximately 1% at 1750°C; it was concluded that further study of this system was necessary. (D.H.M.)

39051 SOLID-PHASE REACTIONS BETWEEN PENTOXIDES OF NIOBIUM AND TANTALUM AND OXIDES OF THE RARE-EARTH ELEMENTS. Savchenko, E. P.; Godina, N. A.; Keler, E. K. pp 108-13 of Chemistry of High-Temperature Materials. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969.

From 2nd All-Union Conference on the High-Temperature Chemistry of Oxides, Leningrad, USSR. See CONF-651160.

Solid phase reactions were studied in the $Ln_2O_3-Nb_2O_5$ and $Ln_2O_3-Ta_2O_5$ systems (Ln = La, Ce, Pr, Nd) over the temperature range 800 to 1800°C. Three types of compounds of general formulas $LnAO_4$, Ln_3AO_7, and LnA_3O_9 (where A, Nb, Ta) were observed. Still another compound type, with the general formula $Ln_3Nb_{17}O_{33}$, was noted in the $La_2O_3-Nb_2O_5$ and $Ce_2O_3-Nb_2O_5$ systems. A definite succession for compound formation during the synthesis process was established. It was shown that a complete analogy between the structural types of the resulting compounds is observed only in the $Nd_2O_3-Nb_2O_5$ and $Nd_2O_3-Ta_2O_5$ systems. The compounds synthesized are of interest for modern technology. (auth)

39052 IRREVERSIBLE POLYMORPHIC TRANSFORMATIONS IN RARE-EARTH OXIDES. Rudenko, V. S.; Boganov, A. G. pp 85-9 of Chemistry of High-Temperature Materials. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969.

From 2nd All-Union Conference on the High-Temperature Chemistry of Oxides, Leningrad, USSR. See CONF-651160.

The mechanism and nature of polymorphic transformation in rare earth oxides were investigated by x-ray studies of the behavior of the oxides under vacuum and at high temperatures (up to 2000 to 2150°C) and by accurate thermoanalysis. Results show a strong dependence of the transition temperature on the nature of the surrounding atmosphere. Data from a study of the transformation processes in the oxides of Pr, Nd, and Sm under different atmospheres (oxidizing, reducing, and neutral) demonstrated the dependence of the transition temperature on the oxidizing–reducing properties of the surrounding environment. The existence of such a dependence definitely indicates that in all three cases the polymorphic transformations are accompanied by chemical reactions leading to a slight change in the chemical composition of the oxide phase. (D.H.M.)

39053 EFFECT OF RARE-EARTH OXIDE IMPURITIES ON THE POLYMORPHISM OF ZIRCONIUM DIOXIDE. Glushkova, V. B.; Sazonova, L. V. pp 90-6 of Chemistry of High-Temperature Materials. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969.

From 2nd All-Union Conference on the High-Temperature Chemistry of Oxides, Leningrad, USSR. See CONF-651160.

The effect of rare earth oxide impurities on the polymorphism of ZrO_2 was studied. Investigation of ZrO_2–rare earth oxide mixtures showed that the reactions involve formation of substitutional solid solutions of the general formula $Zr^{4+}_{1-x}M^{3+}_{x}O^{2-}_{2-\frac{x}{2}}\square_{\frac{x}{2}}$. It was shown that the solubility of the rare earth oxide in the monoclinic form of ZrO_2 does not exceed 1 to 2 mol% and remains almost constant over the rare earth series. Their solubility in the tetragonal modification was about 4% at 1200°C, and rises with increases in temperature. The transformation temperature decreases with increases in the amount of rare earth oxide in solid solution, and with decreases in rare earth ionic radius. It was concluded that the best materials to stabilize ZrO_2 in the cubic form are the oxides of the heavy rare earths and of Y. Minimal amounts of oxide impurities (3 to 7 mol%) are required to produce stable solid solutions. (D.H.M.)

39054 SEVERAL LAWS IN THE FORMATION OF OXIDES OF TRANSITION METALS OF SUBGROUPS IVa AND Va. Tskhai, V. A.; Gel'd, P. V.; Shveikin, G. P.; Perelyaev, V. A. pp 20-4 of Chemistry of High-Temperature Materials. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969.

From 2nd All-Union Conference on the High-Temperature Chemistry of Oxides, Leningrad, USSR. See CONF-651160.

Structural characteristics and overlap integrals S (d_ϵ, d_ϵ) for several transition metal oxides are tabulated. Results show that the d_ϵ-orbital overlap increases in the sequence of the isostructural oxides: V → Ti → Nb → Zr → Ta → Hf. This generally leads to an increase in Me–Me bond shielding with the number of intermediate oxides decreasing accordingly. If the plot of heat of formation as a function of relative oxygen content is characterized for the V–O system by a greater curvature, such curvature will in turn subsequently decrease in the Ti–O and Nb–O systems. It is to be presumed that for the Zr–O, Hf–O, and Ta–O systems, which have a substantially larger d_ϵ–orbital overlap due to the larger Me–Me bond shielding, the dependency curve will assume a concave form. (D.H.M.)

39055 SOME RESULTS OF THEORETICAL CALCULATIONS USING MATHEMATICAL STATISTICS AND ELEMENTS

OF PROBABILITY THEORY AS APPLIED TO PHASE EQUILIBRIA. Bondar, I. A.; Toropov, N. A.; Koroleva, L. N. pp 25-9 of Chemistry of High-Temperature Materials. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969.

From 2nd All-Union Conference on the High-Temperature Chemistry of Oxides, Leningrad, USSR. See CONF-651160.

Calculations were performed using mathematical methods that enabled their comparison with the results of experimental studies. A linear or parabolic dependence of density, melting, and liquidus temperature on composition was established for the $(La, Sm)_2SiO_5$, $La_2O_3-SiO_2$, $Sm_2O_3-SiO_2$, and $Yb_2O_3-SiO_2$ systems. (auth)

39056 DEPENDENCE OF THE COEFFICIENT OF THERMAL EXPANSION OF STABILIZED ZIRCONIUM DIOXIDE ON THE RATIO OF CUBIC AND MONOCLINIC PHASES. Karaulov, A. G.; Grebenyuk, A. A.; Belik, V. Ya.; Rudyak, I. N. pp 48-52 of Chemistry of High-Temperature Materials. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969.

From 2nd All-Union Conference on the High-Temperature Chemistry of Oxides, Leningrad, USSR. See CONF-651160.

It was found that there is an interrelation between the temperature dependence of the thermal expansion coefficient and the ratio of cubic and monoclinic phases in ZrO_2 specimens. This occurs independently of whether the monoclinic phase results from incompletely stabilized specimens or from introduction of monoclinic phase additives. It was also found that the maximum value of the thermal expansion coefficient over the range 25 to 900°C occurs in specimens composed only of stabilized ZrO_2 (14 to 15 · 10^{-6}/°C). This decreases to 2.5 to 3.1 · 10^{-6}/°C with increase of monoclinic phase content of the specimen to 40 to 60%. It was shown that the presence of more than 20% monoclinic phase in specimens of 19 to 22% porosity causes abrupt change in volume in the temperature range 850 to 1200°C. The magnitude of these changes increases with increased amount of the monoclinic phase, and results in a hysteresis, with expansion of specimens on cooling from 1200° to room temperature. At 30 to 60% monoclinic phase content, an expansion anomaly is observed in ZrO_2 specimens at temperatures up to 2000°C. However, the amount of monoclinic phase in such specimens decreases from 40 to 60% to 10% (as a result of CaO redistribution and additional ZrO_2 stabilization) on specimen anneal at 2000 to 2300°C. This causes disappearance of the expansion anomaly. (auth)

39057 CHROMITES OF THE RARE-EARTH ELEMENTS AND SOME OF THEIR PHYSICOCHEMICAL PROPERTIES. Pavlikov, V. N.; Shevchenko, A. V.; Lopato, L. M.; Tresvyatskii, S. G. pp 57-62 of Chemistry of High-Temperature Materials. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969.

From 2nd All-Union Conference on the High-Temperature Chemistry of Oxides, Leningrad, USSR. See CONF-651160.

Results of a study on rare earth chromite single crystals from six phase diagrams of $Ln_2O_3-Cr_2O_3$ type (Ln = La, Nd, Sm, Gd, Y, Sc) are presented. The study of phase transformation in $Ln_2O_3-Cr_2O_3$ system was conducted using an anneal-quench method from temperatures of 1600 to 2500°C. All systems studied (with the exception of the $Sc_2O_3-Cr_2O_3$ system) belong to one type, and are distinguished primarily by their compound melting temperature and eutectic-point coordinates. The chromites of La, Nd, Sc, Yb, and Gd melt congruently at temperatures of 2300 to 2450°C. It appears general for all systems studied that there is no apparent solid solubility. The ir absorption spectra of Y and all rare earth chromites (except the chromites of Ce and Lu) were studied. The phase transformation in the chromites of La, Nd, Pr, Sm, Gd, and Y were studied in air over the temperature range 20 to 900°C. It was established that lanthanum chromite has a reversible polymorphic transformation at 290 ± 5°C. No transformations or associated heat and volume effects were noted for the chromites of Pr, Nd, Sm, Gd, and Y in the temperature range investigated. (D.H.M.)

39058 THE SYSTEM $BeO-Al_2O_3-MgO$ AT SUBSOLIDUS TEMPERATURES. Reeve, K. D.; Buykx, W. J.; Ramm, E. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Aust. Ceram. Soc., 5: 29-32(May 1969).

Compounds formed during subsolidus annealing of sintered powder mixtures of BeO, Al_2O_3, and MgO were determined. The most probable composition of the ternary compound is 3 BeO · 8 Al_2O_3 · 5 MgO. The expected binary compounds were found with the exception of 3 BeO · Al_2O_3. A suggested subsolidus section of the ternary phase diagram is presented as well as more detailed x-ray diffraction data for the ternary compound than given before. (auth) (Australia)

39059 COHERENT NEUTRON SCATTERING FROM POLYCRYSTALLINE GRAPHITE. Takahashi, Hiroshi (Brookhaven National Lab., Upton, N. Y. Japan Atomic Energy Research Inst., Tokai). Nucl. Sci. Eng., 37: 198-215(Aug. 1969).

The coherent neutron scattering from polycrystalline graphite was calculated using a sampling method with the Yoshimori–Kitano model and the Young–Koppel force constants. The calculations were compared with experimental results obtained by others and it was found that agreement between the calculations and the experimental results was very good. For Carvalho's experiment, which corrects for multiple scattering, the agreement was good for the range of small momentum transfer (α) while for the experiments of Eremeev et al. the agreement was best for the range of intermediate α. A comparison of the dispersion relation, polarization vector, and the dynamical structure factor for the Yoshimori–Kitano model and the Young–Koppel model indicated that the difference in the scattering laws is mainly due to the difference in the dispersion relations. A code called "ONE-PHONON" which uses a sampling method to calculate the scattering law is described. It is suggested that the measurement of the scattering law for each mode in pyrolitic graphite will give valuable information about the lattice dynamics of graphite. (auth)

39060 IDENTIFICATION OF INTERMEDIATE PHASES FORMED BY DIFFUSION IN THE BORON–NICKEL SYSTEM. Giancola, John Robert. Tucson, Ariz., Univ. of Arizona, 1968. 102p.

Thesis.

An investigation of the binary boron–nickel system was accomplished using an electron probe microanalyzer and x-ray diffraction techniques. Interdiffusion experiments were performed using high-purity elemental materials. Diffusion anneals were conducted in the temperature range 797 to 861°C for times up to 1008 hours. Two distinct laminar intermediate phase regions were detected at the diffusion interface. The phase coherent with the nickel was identified as orthorhombic Ni_3B. The phase adjacent to the Ni_3B interface was identified as tetragonal Ni_2B. None of the other intermediate phases reported to exist in the boron–nickel binary system was detected. Both the Ni_3B and Ni_2B phases had extremely limited solubility ranges, well within the detection limits of the methods and instruments employed. Through the use of the electron probe microanalyzer it was possible to compare x-ray fluorescence intensity measurements for nickel. These comparative intensity measurements were used to establish nickel concentration gradient profiles across the diffusion interface. Nickel concentration gradients were found to be extremely steep in the regions between the phases formed at the diffusion interface. Boron concentation profiles could not be determined as a cross-correlation because the characteristic x-ray fluorescence from boron is of such low energy (long wavelength) as to have been absorbed in the path from the specimen to the proportional counter employed in this electron probe. While a concentration gradient diffusion analysis such as that developed by Boltzmann and Matano could not be applied to the boron–nickel system, it was possible to measure penetration constants for the rate of growth of the phases formed. The rate of growth of the Ni_3B phase was found to be a parabolic function of time, while the rate of growth of the Ni_2B phase remained unverified due to its physical inability to resist damage inherent in metallographic surface preparation. (Disser. Abstr.)

39061 THE MICROSTRUCTURE AND MICROPROPERTIES OF WC–Co ALLOYS. French, David N. (Ingersoll-Rand Research Center, Princeton, N. J.). Int. J. Powder Met., 5: No. 3, 47-60(July 1969).

The mechanical behavior of WC–Co alloys is discussed in terms of the properties of the individual phases, rich solid solution of Co and WC, and the interaction between WC and the binder Co alloy during sintering and subsequent cooling. Morphology of the carbide grains is explained by the crystallographic polarity of WC. Properties of the binder alloy and the deformation of WC crystals are given. Microhardness measurements of carbide grains in the vicinity of other carbide grains and cobalt pools were made to explain deformation characteristics. A model based on the Ansell–Lenel theory is presented to explain the temperature stresses in the WC phase. (auth)

Radiation Effects

Refer also to abstracts 39004, 39007, 39008, 39012, and 40317.

39062 (BNWL-1056-A) IRRADIATION OF GRAPHITE AT TEMPERATURES OF 300 TO 1200°C. Helm, J. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 98p. Dep. CFSTI.

A large variety of graphites have been irradiated at temperatures from 300 to 1200°C to maximum neutron fluxes of 2.7 × 10^{22} nvt (E > 0.18 MeV). As temperatures and neutron fluxes increased, bulk expansion of the graphite became the controlling

behavior in all orientations. Materials that were well graphitized, highly crystalline, isotropic, and had a high coefficient of thermal expansion showed the lowest contraction at moderate fluxes. The dimensional-change data for all graphite types may be separated into two bands. The first band represents data for samples irradiated in the temperature range 300 to 800°C. The second band, showing a highly accelerated damage rate, represents data for samples irradiated at 900 to 1200°C. Thus, the transition from the lower damage rate to the higher one takes place over narrow temperature range (~800 to 900°C). The data are grouped closely within each band. These observations are based on relatively small samples, generally less than ½ in. diameter by less than 4 in. long. While the behavior of these small samples may not exactly represent the behavior of larger pieces, it is felt that expansion will ultimately be the controlling behavior in the larger sizes also. (auth)

39063 (BNWL-1058, pp 3.1-11) NUCLEAR GRAPHITE. Nightingale, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Research on the microstructure of polycrystalline graphite and structural changes caused by gas-graphite reactions is reported. Thermal reactions between graphite and water vapor were studied. Hydrogen reactions with graphite under the influence of microwave excitment resulted in a deposit believed to be a composition involving Si and O. Tests conducted to determine the rates of radiolytic reactions of CO_2 and H_2 produced results that indicate a small decrease in the G value for formation of both CO and CH_4 at about 3500 to 600 VP M. Progress on tests to determine the effects of sample size on graphite irradiation behavior is reported. (J.R.D.)

39064 (BNWL-1058, pp 4.1-6) FUEL DEVELOPMENT FOR GAS-COOLED REACTOR: HTGR GRAPHITE STUDIES. Nightingale, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A computer program was used to analyze the results of water injection tests conducted at the Dragon Reactor. Results indicate that radiolytic reactions may make a significant contribution to the steady-state coolant gas composition in the reactor. Tests to determine the effects of high-temperature neutron irradiation on graphite are in progress. Preliminary results are presented based on surface area measurements. (J.R.D.)

39065 (BNWL-1058, pp 5.1-58) NUCLEAR CERAMICS. Nightingale, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Fabrication of an assembly to test in-pile creep of PuO_2-UO_2 fuels is reported along with installation of a hot-press glovebox facility for use in densification of ceramic fuels. A sonic measuring device for use in determining compressibility of mixed oxide fuels is being tested using CaF_2. Research progress is also reported on thermal diffusivity of PuO_2-UO_2, high temperature creep of fast-reactor oxide fuels, electric conductivity of CeO_2, irradiation damage in UO_2, oxygen-to-metal ratios in oxides, fuel migration, properties of mixed oxide fuels, and radiation effects on fast-reactor oxide fuels. (J.R.D.)

39066 METHOD FOR MAKING RADIATION INDUCED CRYSTALLIZED GLASS. Ernsberger, Fred M. (to PPG Industries Inc.). U. S. Patent 3,454,386. Filed Jan. 13, 1965.

Production of strengthened articles by surface crystallization of glass materials is described. Strengthened glass articles are characterized wherein the surface portions of the glass contain randomly-oriented silica-O crystals and the crystallizable glass base contains titanium dioxide and a metal such as silver, gold, copper, or platinum. A method is described of nucleating surface portions of a crystallizable glass article by means of high-energy radiation, especially electrons. (Offic. Gaz.)

39067 DAMAGE CREATED IN CALCITE CRYSTALS BY RADIATION. Brito, Ubirajara (Univ. Federale, Bahia, Brazil); Lalou, Claude. Earth Planet. Sci. Lett., 6: 155-60 (May 1969). (In French).

A method for revealing tracks caused by heavy charged particles in calcite crystals was devised. Various samples of calcite and micas, covered or not by heavy metals deposits, were irradiated with thermal neutrons or with 3-GeV protons. A comparison of the tracks revealed in the two cases showed that there are really tracks caused by heavy charged particles that are developed in the calcite and not dislocations or other corrosion figures. (auth)

Plastics and Other Materials

Refer also to abstracts 37995, 38237, and 38919.

39068 (BNL-13732) DEVELOPMENT OF CONCRETE-POLYMER MATERIALS. Manowitz, B.; Steinberg, M.; Kukacka, L.; Colombo, P. (Brookhaven National Lab., Upton, N. Y.). June 1969. 18p. (CONF-690805-2). Dep. CFSTI.

From Symposium on Utilization of Large Radiation Sources and Accelerators in Industrial Processing, Munich, Germany.

Results of research indicate that preformed mortar and concrete can be fully impregnated with monomer and polymerized by either radiation or thermal-catalytic techniques. The polymer concrete formed has been found to have substantially improved structural and durability properties compared with those of conventional concrete. The improvement in properties appears to be a function of polymer loading. Maximum increases in strength up to almost four times the control specimen have been obtained. Thermally treated concrete polymer shows an approximate 7 to 15% lower strength value than the radiation-treated material but still much greater than that of control concrete. Remarkable improvements in durability properties have been obtained with all of the monomer systems tested. Methyl methacrylate appears to give the greatest improvement, acrylonitrile the least. Composites with compressive strengths >1330 kgf/cm² at a temperature of 143°C have been attained using a 60% styrene + 40% trimethylopropane trimethylmethacrylate solution. The high strength and anticipated resistance to brine and distilled water make this system a promising candidate for flash distillation units in water desalination plants. The impregnation of fiber reinforced concrete greatly improves the flexural strength. (auth)

39069 HIGH-GRADE CEMENTS FOR RADIATION SHIELDS. Braniski, A. Zem.-Kalk-Gips, 57: 231-2(1968). (In German).

Chemical and mixture compositions of Ba cements, mixtures of Portland cements, and mixtures of Portland cement with barytes, are reported and discussed in relation to the composition of heavy concrete for radiation shielding. (auth)

39070 SLIDING FRICTION AND WEAR OF POLYTETRAFLUOROETHYLENE BALL BEARING. PART 1. EFFECTS OF FILLERS AND GAMMA IRRADIATION. Karasawa, Koreyoshi (Osaka City Univ.); Inoue, Toshizo Junkatsu, 14: 89-94(Feb. 1969). (In Japanese).

The effects of radiation on friction of polytetrafluoroethylene (PTFE) ball bearings filled with 5 wt % graphite (typical filler percent) were studied. The frictional forces were measured by an apparatus that was designed and built in the laboratory, and the experiments were carried out with specimens of 1 cm² area which were pressed against a rotating steel disk, a rotating hard chrome plated steel disk, and a rotating plastic coated steel disk. The conditions for friction tests were as follow: load, 30 kg/cm²; room temperature, 15 ± 2°C; the total sliding distance, 100 meters; sliding velocity, from 0.04 to 8.55 cm/sec. The coefficients of friction for PTFE filled with graphite against every kind of disk increased rapidly to their minimums between 2 to 5 wt % of the filler quantities. Both PTFE filled with graphite and one filled with molybdenum disulfide, against polyester coated disk had excellent properties. In the case of sliding on a hard chrome plated steel disk, the wear of these sliders was very small and the performance was good. For γ-irradiated materials the coefficients of friction against a rotating steel disk by every sliding velocity had minimum values near the value of 10^7 rad. The relations between the amount of irradiation and the total wear of 100 meters sliding, notwithstanding the various sliding velocities, showed straight lines on the logarithmic scale coordinates. (auth) (NSA of Japan)

PHYSICS (GENERAL)

Astrophysics and Cosmology

39071 (AEC-tr-7074) PLASMA RADIATION PROCESS IN ASTROPHYSICS. Kaplan, S. A.; Tsytovich, V. N. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated from report NP-17701. 91p. Dep. CFSTI.

An abstract for the original Russian report appeared previously in NSA 23: 6988. (M.O.W.)

39072 FAR-INFRARED NIGHTSKY EMISSION ABOVE 120 KILOMETERS. Houck, J. R.; Harwit, Martin (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 157: L45-8(July 1969).

The existence of a flux of $5(+5, -2.5) \times 10^{-9}$ W cm^{-2} sterad^{-1} in the spectral range from 0.4 to 1.3 mm, at an altitude above 120 km was verified. This result is discussed in the context of other recent investigations. (auth)

39073 THERMAL INSTABILITY IN THE PRESENCE OF HALL CURRENT. Raghavachar, M. R. (Indian Inst. of Science, Bangalore). Astron. Astrophys., 2: 18-21(May 1969).

The effect of Hall current on the thermal instability which was studied by Field (1965) with a view of explaining the existence of non-self-gravitating astronomical objects is considered. It is found that Hall current does not change the stability criteria but introduces additional modes of propagation which do not give rise to any new criteria. However, it affects the growth rates of other modes. (auth)

Cosmic Ray Exposure Ages

39074 OBSERVATIONS ON SPACE IRRADIATION OF INDIVIDUAL CRYSTALS OF GAS-RICH METEORITES. Lal, D.; Rajan, R. S. (Tata Inst. of Fundamental Research, Bombay). Nature (London), 223: 269-71(July 19, 1969).

Fossil tracks in several silicate crystals present in the dark phases of gas-rich meteorites (Kapoeta and others) show that the crystals were irradiated at low temperatures as individuals in a very low-density atmosphere by corpuscular radiation of cosmic composition. (auth) (UK)

39075 PRIMITIVE LOW-ENERGY PARTICLE IRRADIATION OF METEORITIC CRYSTALS. Pellas, P. (CNRS, Paris); Poupeau, G.; Lorin, J. C.; Reeves, H.; Audouze, J. Nature (London), 223: 272-4(July 19, 1969).

Observations are reported of large track densities ($\approx 10^9$ cm^{-2}) produced by iron-group nuclei at the surface of certain crystals and chondrules in the dark parts of gas-rich meteorites. An early solar origin of these particles is inferred. (auth) (UK)

39076 MEASUREMENTS OF RADIOACTIVITY IN THE METEORITE OF APRIL 25TH, 1969. Rundo, J. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 223: 276-7(July 19, 1969).

Fragments of this meteorite, which fell in Ireland, were examined for γ emission by scintillation spectrometry. The gamma spectrum for the first fragment indicated a response confined to the region below 3.15 MeV. Seven observed peaks were attributed to annihilation radiation, annihilation radiation coincidences, ^{137}Cs, ^{54}Mn, ^{22}Na, ^{40}K, and ^{26}Al. The presence of ^{137}Cs was unexpected, and was attributed to fragments of the asbestos roof pierced by the meteorite. Approximate values for ^{54}Mn content were 75 to 110 dpm/kg, and for the K content 0.06 to 0.10%. The second larger fragment indicated ^{54}Mn 75 to 130 dpm/kg, ^{22}Na 60 to 90 dpm/kg, ^{26}Al 35 to 50 dpm/kg, K 0.09 to 0.13%, and total positron emitters (mainly ^{22}Na and ^{26}Al) 95 to 170 dpm/kg. These concentrations are similar to those reported for a range of stony meteorites. Glass-like fragments from the point of fall were also examined, and considered not to be of extra-terrestrial origin. (UK)

39077 URANIUM CONTENT OF SOME STONE METEORITES AND THEIR Pu-Xe DECAY INTERVAL. Fisher, D. E. (Univ. of Miami, Florida). Nature (London), 222: 1156(June 21, 1969).

Discussions have recently been published as to whether or not the Pu-Xe and I-Xe decay intervals of stone meteorites are concordant, and on the implications of this to models of galactic nucleosynthesis. Kuroda (Nature, 216: 442(1967) and 221: 726 (1969)) states that these intervals are concordant, while Reynolds (Nature, 218: 1024(1968) and 221: 729(1969)) believes that the question is still open. Discrepancies in some eucrites are attributed by Kuroda to tellurium interferences with the determination of uranium abundances by neutron activation analysis. It was thought desirable to test this possibility by measuring the uranium by a different technique, and studies are reported using the fission track method. Results did not agree with Kuroda's calculations, and the decay intervals hence remain discordant, so that the question of concordancy of meteoritic decay intervals is still open. The problem of sampling difficulties in the interpretation of Xe and U data is emphasized; the U abundances within most meteorites show variations by about a factor of two, indicating that it is necessary to perform U and Xe measurements on thoroughly crushed and mixed aliquots if the matter of the Pu-Xe decay interval is to be settled. (UK)

39078 THE POSSIBILITY OF EXTINCT SUPERHEAVY ELEMENTS OCCURRING IN METEORITES. Dakowski, M. (Inst. of Nuclear Research, Swierk, Poland). Earth Planet. Sci. Lett., 6: 152-4(May 1969).

Anomalies of Xe and Kr isotopic composition in meteorites are discussed. A possible explanation by spontaneous symmetric fission of superheavy elements is proposed. (auth)

Stars

Refer also to abstracts 39277 and 39315.

39079 STRONG OPTICAL POLARIZATION OBSERVED IN VY CANIS MAJORIS. Shawl, Stephen J. (Univ. of Texas, Austin). Astrophys. J., 157: L57-8(July 1969).

Strong polarization in ultraviolet light was found for the OH emission source VY Canis Majoris. The polarization drops steeply, and its position angle rotates over 60° from the ultraviolet to the infrared. (auth)

39080 OSAWA'S PECULIAR STAR HD 221568. Kodaira, Keiichi (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 157: L59-62(July 1969).

This Letter briefly discusses the first scanner observations of the continuum of an extraordinary peculiar A star, HD 221568, and calls attention to the additional peculiarities of this object. (auth)

39081 INFRARED EMISSION FROM PLANETARY NEBULAE. Woolf, N. J. (Univ. of Minnesota, Minneapolis). Astrophys. J., 157: L37-40(July 1969).

Broad-band 11.5-μ observations are reported for eight planetary nebulae, four W-R and Of stars, and three symbiotic stars. The largest infrared excess is found for BD+30°3639. (auth)

39082 LINE STRENGTHS FOR SOUTHERN OB STARS. I. SPECTROGRAMS WITH HIGH DISPERSION. Buscombe, William (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc., 144: 1-30(1969).

For 121 southern stars of spectral types between O5 and A3, including 35 supergiants, equivalent widths and values of $v_e \sin i$ were measured from direct-intensity tracings of spectrograms with original dispersion 150 μ Å^{-1}. The central depths of the Balmer Lines of H(I) for slow rotators were found to increase monotonically with reciprocal temperature θ_e, in close agreement with predictions on the basis of model atmospheres computed by Mihalas (1964 and 1965). For the stars from B3 to B9, the strengths of the He(I) triplet lines 4026, 4471 were found to follow a single relation with the intrinsic color-index Q. At class B(I), however, the mean equivalent width for these lines ranges over a factor of 3, increasing from supergiants through stars near the main sequence to those with hydrogen in emission, and showing a positive correlation with $v_e \sin i$. (auth) (UK)

39083 LINE STRENGTHS FOR SOUTHERN OB STARS. II. OBSERVATIONS WITH MODERATE DISPERSION. Buscombe, William (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc., 144: 31-9(1969).

From microphotometer tracings of prismatic spectrograms the equivalent widths and central depths of Hγ and Hδ were used to estimate the absolute visual magnitude for about 380 stars earlier than class A7, including over 60 class-I supergiants. Similar data are also given for the helium singlet and triplet lines in the violet region for the O and B stars, and MK types are estimated. (auth) (UK)

39084 OBSERVATIONS OF SOUTHERN RR LYRAE STARS. Clube, S. V. M.; Evans, David S.; Jones, D. H. P. (Royal Observatory, Cape Town). Mem. Roy. Astron. Soc., 72: 101-84(1969).

Photometric and spectroscopic data for 62 southern RR Lyrae variables brighter than B = 14 at minimum, obtained at the Cape and Radcliffe Observatories during the last five years, are presented. The aims of the investigation were to provide sufficient data for each star to assist in population classification and to determine the statistical parallaxes for pulsating stars with periods less than one day broken down by population groups. The following characteristics of each variable were derived: (1) period, (2) light curves in three colors, (3) mean radial velocity, and (4) spectral types from metal (Ca II) and hydrogen lines, producing an estimate of Δs. (UK)

39085 EVOLUTION WITH MASS EXCHANGE IN CLOSE BINARY SYSTEMS OF TOTAL MASS 2.5 M. Refsdal, S.; Weigert, A. (Univ. of Nebraska, Lincoln. Univ., Goettingen, Ger.). Astron. Astrophys., 1: 167-79(Feb. 1969).

For three close binary systems of the same total mass ($M_1 + M_2 = 2.5\ M_\odot$), the evolution was calculated from the main-sequence stage through the phase of mass exchange between the components. If the original primary starts to lose mass after completion of its central hydrogen burning, a slow phase of mass exchange occurs during which the computed systems resemble the observed semi-detached systems of total mass around 2.5 $M_\odot$. After this phase of mass exchange, the now less-massive components become white dwarfs. (auth)

39086 ATMOSPHERES AND EXTENDED ENVELOPES OF CENTRAL STARS OF PLANETARY NEBULAE. Boehm, K. H. (Univ. of Washington, Seattle). Astron. Astrophys., 1: 180-92 (Feb. 1969).

The atmospheric structure and the energy distribution of the emergent flux $F_\nu(0)$ was studied for 16 model atmospheres in the temperature range $4.3 \times 10^4 \leq T_{eff} \leq 1.8 \times 10^5$K. Most of the models lie on or close to the Harman–Seaton sequence. The method of calculating the hydrostatic nongrey radiative equilibrium models is similar to the one used by Böhm and Deinzer (1965, 1966). Improved absorption coefficients $\varkappa_\nu$ based on the data given by Seaton (1958) and Flower (1968) were used for the ions of C, N, O, and Ne. For models with $T_{eff} \leq 1.25 \times 10^5$°K considerable changes in $F_\nu(0)$ (due to the changes in $\varkappa_\nu$) relative to the earlier results occur between the Ne(IV) and O(VI) absorption edges. The influence of moderate changes of the hydrogen-to-helium abundance ratio on the stratification and on $F_\nu(0)$ was investigated. It is shown that for models lying sufficiently close to the instability limit due to the radiative acceleration, the stratification and $F_\nu(0)$ are extremely sensitive to small changes in the surface gravity. One easily finds "atmospheres" with a thickness comparable to or larger than one stellar radius. The occurrence of Wolf–Rayet and Of spectra for a considerable fraction of the central stars may be related to such extended envelopes and their possible instability. (auth)

39087 POSSIBILITY OF SYNTHESIS OF PROTON-RICH NUCLEI IN HIGHLY EVOLVED STARS. I. Arnould, M.; Brihaye, C. (Univ. Libre, Brussels). Astron. Astrophys., 1: 193-207(Feb. 1969). (In French).

The possibility of production of p elements at temperatures $1 \lesssim T_9 \lesssim 2$ in the inside of very highly evolved stars is considered, the mechanism under investigation being the isobaric transformation of nuclei synthesized previously in a neutron-capture chain. It is shown that, in fact, only few proton-rich nuclei can be produced by such a process, especially if a direct $e-\nu$ coupling leads to a very rapid stellar evolution. More precisely, if pair annihilation by $e^+ + e^- \rightarrow \nu + \bar{\nu}$ is effective, it appears that a relatively important quantity of only ^{113}In and ^{115}Sn is likely to be produced; some ^{114}Sn and ^{166}Er can also be formed. On the contrary, if the photon luminosity is dominant, ^{94}Mo, ^{106}Cd, ^{114}Sn, ^{164}Er, ^{180}W, and to a lesser extent ^{126}Xe, ^{152}Gd, ^{158}Dy, and ^{196}Hg, can also be synthesized rather abundantly thanks to isobaric transformations. In particular, one of the most important results of this study is to present a possibility of explanation of the superabundance of ^{166}Er with regard to the neighboring p elements. (auth)

39088 ON THE AGES OF δ CEPHEI STARS. Kippenhahn, Rudolf; Smith, Lindsey (Univ., Goettingen, Ger. Univ. of Colorado, [Boulder]). Astron. Astrophys., 1: 142-6(Feb. 1969).

A period-age relationship for δ Cephei stars is derived from stellar evolution theory. The scatter is estimated theoretically and compared with the observed period scatter for cepheids of equal age. It is suggested that within a certain range of age an age determination for star clusters as found from the periods of cepheids seems to be better than that from the turn off point method. (auth)

39089 ECLIPSING VARIABLE χ^2 Hya = BV 722. Mauder, Horst; Koehler, Ulrich (Univ., Erlangen, Ger.). Astron. Astrophys., 1: 147-52(Feb. 1969). (In German).

Photoelectric light curves were obtained for the eclipsing binary χ^2 Hya. The colors were B of Johnson's UBV system and b = 422 mμ, v = 363.5 mμ defined by interference filters of half width 9 mμ. The photometric elements are $r_g = 0.346$, $r_k = 0.194$ and $i = 76.2°$. The secondary is very uncommon, having a mass of only 0.65 $M_\odot$, a radius of 2.3 $R_\odot$ and a spectral type around B 8.5. (auth)

39090 DIFFERENTIAL CURVE-OF-GROWTH ANALYSES OF FOUR LATE-TYPE GIANT STARS. Griffin, R. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 143: 381-406(1969).

Differential curve-of-growth analyses of γ and θ^1 Tau (Hyades giants), β Herculis, and HD 101013 (a barium star) are presented, using as a standard of reference the metal-poor K2 giant Arcturus. The determination of representative stellar temperatures from color indices is discussed. Results of relative abundance analyses are very sensitive to the temperatures employed; errors in abundance determinations are minimal in the case of relative abundances within one star, but may prevent the unambiguous detection of overall differences between stars unless they exceed a factor of two. Slight relative deficiencies of Ca and Ti are noted in the Hyades stars, but the small overall enrichment of metals reported by other authors cannot be confirmed without placing a stringent lower limit to the temperature difference between these stars and Arcturus. Owing to a large uncertainty in the temperature of β Her two possible abundance results are given. In HD 101013 it is found that the s-process elements available to investigation are four or five times more abundant (relative to hydrogen) than in the Sun, while Ti and V are almost as deficient, in comparison with the Sun, as they are in Arcturus. (auth) (UK)

39091 FIRST OBSERVATION OF ARCTURUS WITH A DOUBLE-PASS SPECTROMETER. Griffin, R. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 143: 341-7(1969).

A short region of the spectrum of Arcturus was scanned with the double-pass system of the McMath solar spectrometer at Kitt Peak National Observatory. The system was shown to have in practice the advantages it was expected to have in theory over single-pass instruments, although its potential was not fully realized in the observations presented. The double-pass photometry revealed no significant errors in the Arcturus Atlas. (auth) (UK)

39092 SOME EFFECTS OF THE INSTRUMENTAL PROFILE IN STELLAR SPECTROPHOTOMETRY, WITH PARTICULAR REFERENCE TO THE ARCTURUS ATLAS. Griffin, R. F. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 143: 319-39(1969).

A method is described of refining an instrumental profile (initially derived from emission-line observations) of a high-resolution stellar spectrograph, by using profiles of the telluric oxygen bands obtained with a solar spectrometer of still higher resolution. Owing to the light thrown into the wings of the instrumental profile, the observed profiles of absorption lines in late-type stellar spectra are substantially shallower (by ~10% of their central depressions) than the true profiles. It is not true that accurate photometry with a high-resolution spectrograph will result in a close resemblance between the spectrum being observed and the observations being made of it. It is also not true that the resemblance can be appreciably improved by any increase in resolving power. Even with accurate photometry, the equivalent widths measured with the spectrograph discussed must be 5 to 10% less than the true values. Other fundamentally similar spectrographs are unlikely to be much better and may easily be much worse. Important improvements in the observational accuracy of stellar line profiles only seem possible by the use of double-pass spectrometers, which unfortunately have low luminous efficiency. (auth) (UK)

39093 U, B, V OBSERVATIONS OF IC 1805. Ishida, K. (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc., 144: 55-72(1969).

54 probable member stars of IC 1805 were observed in U, B, V colors using the 36-in. reflector at the McDonald Observatory. The extinction characteristics of absorbing matter are discussed by using 79 probable member stars along with 25 stars observed by Hoag et al. (1961) which concentrate at the center of the cluster. The amount of reddening of stellar light is compared to the absolute interstellar absorption (Ishida & Kawajiri 1968) which is obtained by comparing the theoretical and the observed ratio of the radio continuum to the Hα brightness of the H(II) region in each line of sight. An average ratio of absorption to reddening, $R = A_v/E_{(B-V)} = 3.8 \pm 0.5$, is obtained in the IC 1805 region. It appears that the color–magnitude diagram consists of a main sequence extending from O5 to about B5 with later stars lying above the main sequence. The age of the cluster, estimated from the turning point at which the cluster sequence departs from the zero-

age main sequence, is about 2.8×10^6 years, which is between NGC 6611 and 6530 or I Ori. (auth) (UK)

39094 GRAVITATIONAL INSTABILITY OF A PLASMA WITH FINITE LARMOR RADIUS. Bhatia, P. K. (Univ. of Jodhpur, India). Astron. Astrophys., 1: 372-3(Apr. 1969).

For the transverse mode of wave propagation, the gravitational instability of a rotating anisotropic plasma was investigated to include the finite Larmor radius (F.L.R.) effect. It was found that Jeans' criterion remains unchanged by F.L.R. effect. (auth)

39095 DYNAMICS OF H II REGIONS WITH THE CENTRAL STAR IN MOTION. Rastwala, M. (Institut d'Astrophysique, Paris). Astron. Astrophys., 1: 431-41(Apr. 1969).

The dynamics of an isothermal H II region is reconsidered for the case in which the central star is in motion. The deformation of the region is calculated. It is found that the front changes from R- to D-type at different times depending on the polar angle and the stellar velocity. The flow is calculated along the axis of the H II region as defined by the rectilinear motion of the star. The equations are integrated numerically using a hodograph transformation and Riemann invariants. The results indicate a strong dissymmetry between the upstream and downstream regions. (auth)

39096 POLARIMETRIC OBSERVATIONS OF MAGNETIC STARS WITH TWO-CHANNEL POLARIMETER. Serkowski, K.; Chojnacki, W. (Univ. of Warsaw). Astron. Astrophys., 1: 442-8(Apr. 1969).

A two-channel polarimeter that eliminates the effects of atmospheric scintillation is described. For correct performance of this instrument the shape of the depolarizer must be accurately plane parallel. For bright stars the mean error is ±0.0004 mag. The observed magnetic stars and eclipsing binary u Herculis do not show changes in plane polarization with time. The circularly polarized component was measured for nine stars, mostly with large interstellar plane polarization; for none of them does the degree of ellipticity exceed 0.02%. (auth)

39097 ABUNDANCE OF IRON IN THE B2 STARS ζ CASSIOPEIAE AND γ PEGASI. Snijders, M. A. J. (Observatory Sonnenborgh, Utrecht). Astron. Astrophys., 1: 452-6(Apr. 1969).

From a careful study of good spectrograms of ζ Cas and γ Peg profiles and equivalent widths of Fe III lines were obtained. By comparing these with profiles and equivalent widths calculated by means of model atmospheres an iron abundance three times greater than the abundance hitherto accepted was found. A preliminary estimate was made that the amount of rotation broadening in the atmosphere of ζ Cas corresponds to 18 km/s. (auth)

39098 ON THE SHELL INSTABILITY OF PLEIONE. Henriksen, R. N. (Queen's Coll., Kingston, Ont.). Astron. Astrophys., 1: 457-66(Apr. 1969).

A model that may explain the instability (1938–1951) of the extended atmosphere of Pleione (28 Tauri) is described. An initial radial magnetic field of approximately 1.3×10^{-2} gauss, is amplified by differential rotation to a maximum value of 1.94×10^2 gauss, so that explosive dissipation of the material occurs after about 9.16 years. The detailed time dependences of the magnetic field and of the radial and angular velocities, acceleration and position of the shell, are given. Comparison is made with the observations. Certain general dependences on the magnetic field, which may be of use in analyzing the behavior of other stars, are also presented. (auth)

39099 STABILITY OF ROTATING STARS. II. THE INFLUENCE OF TOROIDAL AND POLOIDAL MAGNETIC FIELDS. Fricke, Klaus (Univ., Goettingen, Ger.). Astron. Astrophys., 1: 388-98(Apr. 1969).

Local stability in the presence of magnetic fields is investigated. For toroidal and poloidal magnetic fields the existence of stationary rotation is discussed, using a linear stability analysis. The stability criteria obtained by this method are also derived in a more intuitive fashion. In the poloidal case the isorotation laws turn out to be secularly unstable. It is found that stationary rotation may be secularly stable only if toroidal field components are present and if, in addition, meridional circulations are absent in the radiative zone of the star. (auth)

39100 LARMOR RADIUS AND COLLISIONAL EFFECTS ON THE GRAVITATIONAL INSTABILITY OF A PLASMA. Bhatia, P. K. (Institut d'Astrophysique, Liege). Astron. Astrophys., 1: 399-402(Apr. 1969).

The simultaneous effects of a finite Larmor radius (F.L.R.) and collisions with neutral atoms are studied on the gravitational instability of a plasma. It is found that Jeans' criterion remains unchanged in the presence of F.L.R. and collisions. (auth)

39101 BEHAVIOR OF NARROW Ca ABSORPTION LINES IN NOVA DELPHINI 1967. Fehrenbach, Ch.; Petit, M. (Observatoires, Marseille). Astron. Astrophys., 1: 403-8(Apr. 1969). (In French).

From July to December 1967 the fine structure of absorption lines of circumstellar calcium ejected from Nova Delphini was analyzed. Two absorptions situated at −870 and −791 km s^{-1} have a little variation; three absorptions at −708, −635, and −645 a change of position. This effect can be explained by the normal behavior of a thin layer in uniform movement. The dates of the ejections and the value of the photosphere radius, 440.10^6 km, are deduced. The calcium radial velocity is -2.4 ± 0.2 km s^{-1}. (auth)

39102 TOTAL CROSS-SECTION MEASUREMENTS FOR 4P-TERM ELECTRON IMPACT FOR Ca I AND Ca II. Schramm, J. (Univ., Kiel). Astron. Astrophys., 1: 409-13(Apr. 1969). (In German).

The total cross sections for electron impact of the 4 $^1P^0$ level of Ca I and the 4 $^2P^0$ levels of Ca II (from the ground state of Ca I) were measured for the maxima of the excitation functions by electron beam-techniques. The results are $(0.56 \pm 0.10)\ \pi\ a_0^2$ for the 4 $^1P^0$ level of Ca I and $(0.071 \pm 0.023\ \pi\ a_0^2$ for the 4 $^2P^0$ levels of Ca II. (auth)

39103 ON THE LOW HYDROGEN CONTENT OF THE Ia SUPERGIANTS OF TYPE B. Underhill, A. B. (Astronomical Inst., Utrecht). Astron. Astrophys., 1: 494-5(Apr. 1969).

The lack of Stark wings of the Balmer lines of hydrogen in Ia supergiant spectra of type B conflicts with the electron densities indicated by the break-off point of the Balmer series in the case of stars of normal composition. Furthermore, the observed H_γ profiles are shallower and have smaller equivalent widths than those predicted by standard LTE theory. These conflicts can be reconciled by postulating that the hydrogen content of the Ia supergiants of type B is at least 1000 times less than the normal hydrogen-rich content. (auth)

39104 RADIAL VELOCITIES OF STARS IN THE VICINITY OF THE OPEN CLUSTER NGC 7380. Underhill, Anne B. (Sterrewacht Sonnenborgh, Utrecht). Astron. Astrophys., 1: 356-64 (Mar. 1969).

Ten stars attributed to the open cluster NGC 7380 were observed for radial velocity. Six of the stars are definitely double-lined spectroscopic binaries, five being new discoveries; the other four may be binaries. The available spectroscopic and photometric information about each star is assembled. Each star is discussed and an attempt is made to find whether these stars form the nucleus of an OB open cluster. It is found that Star 1 (= HD 215835, type O6), Star 4 (type B0), Star 6 (Type B1), and possible Star 10 (early B type) are at the same distance; Star 2 (Type B0.5), Star 3 (Type B1), and Star 7 (Type O9) are probably behind the first group of stars; Star 5 (Type F), Star 8 (Type B3), and Star 9 (Type B8) are foreground objects. The stars are identified in a chart. Most of the stars, brighter than 11th magnitude, which have been attributed to NGC 7380 by Hoag, Johnson et al. (1961) are not at the same distance as HD 215835, the star which is usually considered to be at the center of the cluster and to be the exciting star for the emission nebula which covers the region. The true distance modulus of the nucleus group is about 12.2 to 12.5 magnitudes. Both Stars 1 and 8 are eclipsing binaries. (auth)

39105 TEMPERATURE GRADIENT IN A SEMI-CONVECTIVE REGION. Gabriel, M. (Institut d'Astrophysique, Cointe-Selessin, Belg.). Astron. Astrophys., 1: 321-4(Mar. 1969).

It is shown that if mixing in a semi-convective region is due to overstability, the adjustment of the distribution of the molecular weight should be such as to bring ∇_ρ close to $\nabla_{s,\rho}$ rather than ∇_T close to $\nabla_{s,T}$ as suggested by Kato. (auth)

39106 ATMOSPHERES OF METAL-DEFICIENT STARS: MAIN-SEQUENCE STARS. Krishna Swamy, K. S. (Goddard Space Flight Center, Greenbelt, Md.). Astron. Astrophys., 1: 297-304(Mar. 1969).

Model atmospheres were constructed for the effective temperatures 4500, 5000, 5500, and 6000°K and for hydrogen-to-metal ratios of 1, 5, 10, 40, and 100 times the solar value. The effect of reduced metal abundance on the atmospheric structure of these stars was studied. This study is of particular interest in relation to the study of subdwarfs. (auth)

39107 EMISSION PROFILES OF "POLE-ON" Be STARS. Kogure, Tomokazu (Kyoto Univ.). Astron. Astrophys., 1: 253-69(Mar. 1969). (In French).

The emission profiles of H_δ for the so-called pole-on type Be stars are considered. The observed profiles are shown with the measured rotational velocity for the five Be stars: HD 32343, HD 58050, HD 58343, HD 202904, and HD 212076. The general

formulas for the theoretical profiles are derived on the basis of the static-atmosphere theory by Miyamoto and Kogure. Some preliminary calculations which are carried out under the condition of pole-on stars, seem to show its utility in the analysis of observed emission profiles. By comparing the observed profiles with theoretical ones, the structure of the extended atmospheres are considered. Some consideration is separately given for the three stars having small rotational velocities: HD 58343 (V sin i = 40 km/s), HD 212076 (130 km/s), and HD 32343 (140 km/s). (auth)

39108 COLLAPSE AND FLARE-UP OF PROTOSTARS. Narita, Shinji; Nakano, Takenori; Hayashi, Chushiro (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 856-7(Mar. 1969).

In a previous paper (Prog. Theor. Phys. (Kyoto), 39: 1448(1968)) the collapse phase of evolution was investigated for a protostar of one solar mass by solving numerically the hydrodynamic equations of motion. In these equations, the dissipation of the energy of mass motion was taken into account, but the energy flow was completely neglected because it is effective only in the surface region. In this letter, the results of new computations for starts of 1/20, 1, and 20 $M_{\odot}$, in which the effect of energy flow both by radiation and by convection is included, are reported. (TSS)

39109 FUNDAMENTAL SEPARATIONS OF CLOSE VISUAL BINARIES. Couteau, P. (Observatoire, Nice). Astron. Astrophys., 2: 126-32(May 1969). (In French).

A list is provided of 84 very close binaries (between 0.07'' and 0.30'') with well-determined separations that can be used to check the resolution of telescopes with large apertures. The binaries are designated by their number in the Aitken catalog, their name, the estimated magnitudes, and the position for 1950. The orbits are identified by the name of the author, and year of computation, and the period. The ephemeris is given with the epoch, the position angle and the separation, often to three decimals for interpolations, but only the first two are significant. Many of the stars have very slow orbital motion and in these cases the analysis of the observations was carried out by taking into account the linear variation of separation, verified by the law of areas. (auth)

39110 EFFECT OF A MAGNETIC FIELD ON THE CONVECTIVE INSTABILITY OF A COMPRESSIBLE POLYTROPIC ATMOSPHERE. van der Borght, R. (Inst. of Geophysics and Planetary Physics, La Jolla, Calif.). Astron. Astrophys., 2: 96-9(May 1969).

The effect of a magnetic field on the onset of thermal convection in a compressible polytropic atmosphere is considered. The linear perturbation equations are integrated numerically and the critical Rayleigh and wave numbers are derived as a function of the magnetic field strength. A comparison is also made with the results obtained from the thin-layer approximation. (auth)

39111 NOVA VULPECULAE 1968 n^0 2. Terzan, A. (Observatoires de Haute-Provence, Lyon). Astron. Astrophys., 2: 100-4(May 1969). (In French).

Photographic observation of the nova Vulpeculae 1968 n° 2 was done on 39 plates taken by the Schmidt telescope (f = 59.4 cm, f/2) of the Haute-Provence Observatory. The photographic magnitudes were determined after two sequences of magnitudes established around the nova Vulpeculae 1968 n° 1, compared with the galactic cluster NGC 6834. A light curve is drawn for the period going from July 4 to December 19, 1968. It appears that: (1) the explosion must have taken place at the latest on July 16, 1968, (2) the evolution is relatively quick and follows the relation given by Kopylov: $M_{max} = -13.7 + 3.6 \log t_3$, (3) the sudden oscillations of brightness, observed in the transition phase are real, and (4) the final decline seems to have begun. (auth)

39112 FORMATION OF ELEMENTS IN THE UNIVERSE. Weigert, Alfred (Univ., Goettingen, Ger.). pp 97-119 of Atome, Kerne, Elementarteilchen. Suessmann, Georg; Fiebiger, Nikolaus (eds.). Frankfurt am Main, Umschau Verlag, 1968. (In German).

The frequency distribution of elements in the universe is discussed. Energy production in the cores of stars and star formation are described. The theory of element formation in the cores of stars is discussed with respect to the iron point and equilibrium process, supernovae, synthesis of heavy elements in stellar cores, and other possible reactions. Element formation before the formation of stars is also considered. (J.S.R.)

39113 ON THE MICROTURBULENCE IN A AND F STARS. Baschek, B.; Reimers, D. (Neue Univ., Kiel). Astron. Astrophys., 2: 240-1(June 1969).

For reciprocal effective temperatures $0.57 \leq \Theta_e \leq 0.71$ the observed microturbulent velocities of main-sequence stars are noticeably larger than outside this temperature range. Values up to nearly sound velocity are found for normal stars as well as for metallic-line stars. This large scatter of microturbulent velocities, however, does not explain that observed for the Strömgren m_1 indices among late A-type stars. (auth)

39114 A NOTE ON THE TEMPERATURE-CORRECTION PROCEDURE FOR LINE-BLANKETED ATMOSPHERES. Wickramasinghe, D. T.; Strittmatter, P. A. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astron. Astrophys., 2: 242-4 (June 1969).

Difficulties associated with both the Avrett-Krook and Mihalas-Morton temperature correction procedures are discussed in the context of heavily line-blanketed model atmospheres. A minor modification to the Avrett-Krook procedure is proposed, which has resulted in very good convergence to flux constancy in all cases so far tested. (auth)

39115 A COMPARATIVE DETAILED ANALYSIS OF 22 SERPENTIS, A HIGH METALLICITY A2 STAR, AND THE STANDARD F0 V: 9 AURIGAE. Provost, J.; Van't Veer-Menneret, C. (Observatoire, Nice. Institut d'Astrophysique, Paris). Astron. Astrophys., 2: 218-39(June 1969).

From photometric studies and high-resolution spectrography of 22 Ser, a supposed Am star, and of 9 Aur, a main sequence F0 star, the following atmospheric parameters were derived: 22 Ser: $\theta_{eff} = 0.65$, log g = 4.44, 9 Aur: $\theta_{eff} = 0.70$, log g = 4.44. Using the appropriate Mihalas models, a comparative study of the two stars by the method of differential curve of growth analysis confirmed the Am character of 22 Ser by the high-microturbulence velocity and the abundance anomalies found. The star 9 Aur shows a solar chemical composition, but a microturbulence velocity, of 4 km/sec, which is too high for a main-sequence F0 star. (auth)

39116 A THEORETICAL HERTZSPRUNG-RUSSELL DIAGRAM FOR THE STAR CLUSTER NGC 1866. Meyer-Hofmeister, E. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Astron. Astrophys., 2: 143-50(June 1969).

A theoretical H-R diagram was constructed for a comparison with the observed diagram of NGC 1866 in the Large Magellanic Cloud. This comparison of the characteristic features of the giant branch stars allows a first detailed check of the results of stellar evolution theory for this special evolutionary phase. For the construction of the H-R diagram isochrones were used. They are based on evolutionary tracks for 3.5 to 5.5 $m_{\odot}$ and include the hydrogen- and helium-burning phases. The mass distribution was taken according to Salpeter's "original mass function" and a scatter in age was assumed according to the duration of the epoch of star formation. The age of the theoretical cluster is a free parameter and is chosen so that one gets optimal agreement with the observed cluster. As a result, one gets an age of 5.8×10^7 years and a distance modulus of about 18.8 for NGC 1866. (auth)

39117 RATES OF ESCAPE FROM ISOLATED CLUSTERS WITH AN ARBITRARY MASS DISTRIBUTION. Henon, M. (Smithsonian Institution Astrophysical Observatory, Cambridge, Mass.). Astron. Astrophys., 2: 151-61(June 1969).

Stars can escape from an isolated cluster only as the result of a single close encounter. The corresponding rates of escape of stars and of kinetic energy are computed for an arbitrary distribution of stellar masses in the cluster. Under two assumptions: spherical symmetry of the cluster and isotropy of the velocity distribution at every point, general expressions are derived. These expressions are evaluated in the case of Plummer's model. Reasonable agreement is found with the results derived from numerical experiments by Aarseth and Wielen. The rate of escape of stars is quite sensitive to the mass distribution: it is typically multiplied by a factor 30 or more when equal masses are replaced by unequal masses. (auth)

39118 A STUDY OF 48 LIBRAE IN THE PERIOD 1950-1962. Faraggiana, Rosanna (Osservatorio Astronomico, Trieste, Italy). Astron. Astrophys., 2: 162-8(June 1969).

Radial velocities of the Na D lines, Hα, He I 5876 and 6678, and Si II 6347 and 6371 and profiles of the Na D lines and Hα were measured on spectra of 48 Librae taken in the period 1950-1962. The radial velocities of the Hα absorption core do not fit on the mean radial velocity curve but indicate that the material from which this line is formed is expanding with a constant velocity of about -25 km s^{-1}. The profiles of the Na D lines and of Hα change during the radial velocity cycle. Some considerations about the shell are given. (auth)

39119 DETAILED ANALYSES OF THE PECULIAR A STARS. I. THE MANGANESE STARS. Strom, Karen M. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astron. Astrophys., 2: 182-94(June 1969).

A detailed model atmosphere analysis is presented for the Mn Ap stars π^1 Boo, 53 Tau, and HD 1909. The values of effective

temperature and gravity for these stars were obtained from a comparison of observed spectrum scans and hydrogen-line profiles with those predicted from the models. This comparison is quite satisfactory and suggests that for optical depths greater than $\tau \sim 10^{-1}$ the atmospheric structure of these Ap stars is not significantly different from "normal" A stars of nearly the same T_{eff}. However, there is some uncertainty in the choice of T_{eff} caused by the unknown but probably significant effects of line blanketing in the ultraviolet. The effects of this uncertainty on the abundance determinations are negligible, except in the cases of He and C, where the uncertainty in the temperature structure may introduce an error of up to a factor of 3 in the abundances. Significant abundance differences exist among these stars. (auth)

39120 BCD CLASSIFICATION FOR 19 CEPHEIDS. I. A DETERMINATION OF INTERSTELLAR REDDENING. Schneider, M. (Observatoire, Nice). Astron. Astrophys., 2: 195-201 (June 1969). (In French).

New results of BCD classification (Chalonge, 1966) for 19 cepheids are presented. These results were obtained by different observers. All the spectra were reduced by a semi-automatic method described elsewhere (Schneider, 1967a) and gave the parameters shown. These observations, added to the results already published (Schneider, 1967b) permit one to define more precisely the (Σ) surface, locus of normal stars of Population I in the BCD diagram and give new values of interstellar reddening for 20 cepheids. (auth)

39121 RADIAL VELOCITIES OF THE GAS IN H II REGIONS AND THEIR ASSOCIATED STARS. Murdin, Paul (Univ. of Rochester, N. Y.). Astrophys. J., 157: 175-81(July 1969).

The radial velocities of stars and gas in H II regions are generally well correlated and suggest that H II regions are not the result of chance encounters. There is, however, a systematic difference in radial velocity between the nebulae and the stars. This difference is not the result of the expansion of the individual nebulae; if it is not due to a systematic error in the system of radial velocities of B stars, it indicates that the population of gas is expanding with respect to B stars embedded in it. (auth)

39122 THE PROFILES OF THE INTERSTELLAR SODIUM D-LINES. Hobbs, L. M. Astrophys. J., 157: 165-73(July 1969).

The profiles of one or both of the interstellar sodium D lines in seventy-seven stars are analyzed. The number of single lines suitable for analysis of individual interstellar clouds is small, mostly owing to overlapping of the generally multiple lines. Theoretical line profiles based on a simple, conventional model do fit acceptably the great majority of the thirty-three measured profiles which are found to be single from a priori conditions. The main data consist of a more restricted set of fifteen lines. Eleven of the fifteen lines indicate a Gaussian velocity distribution for the absorbers; four indicate an exponential distribution. The rms velocities within the Gaussian clouds require (with one possible, but unlikely, exception) that the clouds be in H I regions. Thermal broadening of the lines is negligible, if a temperature $T \sim 100°K$ is assumed; the turbulent velocity distribution is thus measured directly. A possible change in the form of the velocity distribution for absorbers which may lie within or near the Orion association is noted. (auth)

39123 INTERFEROMETRIC STUDIES OF INTERSTELLAR SODIUM LINES. Hobbs, L. M. (Univ. of California, Santa Cruz). Astrophys. J., 157: 135-63(July 1969).

Interferometric, photoelectric scans of one or both of the interstellar sodium D lines in the spectra of seventy-seven stars were obtained with a Pepsios spectrometer. The full half-intensity width of the passband used was 0.010 Å, or 0.51 km sec^{-1}. The line profiles obtained had probable errors in intensity of about 6% for the faintest stars observed ($V \sim 5.0$), and a few percent for brighter stars; the probable errors in the radial velocities were 0.1 to 0.2 km sec^{-1}; the limit of detection for weak lines was an equivalent width of less than 1 mÅ. Overlapping stellar absorption lines presented no serious difficulties, even for stars as late as spectral type F8; overlapping telluric water-vapor lines were less easily circumvented. The qualtitative results were the following. (1) The tenfold improvement in resolution over that used by Adams showed that, for the sixty-five stars common to both programs, over 70% of the lines listed by Adams as single were multiple. The few single lines remaining were confined almost entirely to stars within 200 pc of the Sun and a few high-latitude stars. (2) Doubling of the D lines due to the presence of sufficiently narrow hyperfine-structure components was rarely observed, if at all. (3) A large variation in the interstellar Ca II/Na I abundance ratio was indicated by a comparison of these data with those of Adams for the calcium lines. (auth)

39124 THE MAGNETIC FIELD VARIATIONS OF HD 188041. Wolff, Sidney Carne (Univ. of Hawaii, Honolulu). Astrophys. J., 157: 253-9(July 1969).

Zeeman measurements of HD 188041 show that the amplitudes of the magnetic field variations are not identical for all elements. During the portion of the cycle spanned by the present observations, the fields derived from lines of Gd II, Mn I, Mn II, and Ca I were essentially constant, the fields of Cr I and Cr II changed by a factor of about 1.2, and the fields of Fe I, Fe II, Ce II, and Ti II changed by a factor of about 1.6. The elements which showed the smallest magnetic field changes showed the largest spectrum variations. Whenever an element was observed in two stages of ionization, the amplitudes of the magnetic and spectrum variations were the same for both. The observations can be explained most easily by the assumption that not all of the various elements are distributed uniformly over the surface of the star. (auth)

39125 PARTIAL RESOLUTION OF ZEEMAN PATTERNS IN THE SPECTRUM OF 53 CAMELOPARDALIS. Preston, George W. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 157: 247-51(July 1969).

Spectroscopic evidence is presented for a magnetic field of −15 kilogauss in the atmosphere of 53 Cam at phase 0.12 cycles prior to positive crossover. (auth)

39126 EXPERIMENTAL INVESTIGATION OF THE STELLAR NUCLEAR REACTION $^{12}C + {}^{12}C$ AT LOW ENERGIES. Patterson, J. R.; Winkler, H.; Zaidins, C. S. (California Inst. of Tech., Pasadena). Astrophys. J., 157: 367-73(July 1969).

The reactions $^{12}C(^{12}C,\alpha)^{20}Ne$, $^{12}C(^{12}C,p)^{23}Na$, and $^{12}C(^{12}C,n)^{23}Mg$ were studied to provide reliable predictions of their cross-sections in the energy region of interest in stellar carbon burning. Many excited-state transitions were observed for the α-particles and protons. Measurements for these particles were made in the center-of-mass energy range 3.23 to 8.75 MeV. The relatively small yield of the $^{12}C(^{12}C,n)^{23}Mg$ reaction was investigated from 4.25 to 6.25 MeV. The new results for these reactions lead to lower cross-sections than previously estimated for the region of astrophysical interest. (auth)

39127 CARBON-BURNING NUCLEOSYNTHESIS AT CONSTANT TEMPERATURE. Arnett, W. D. (California Inst. of Tech., Pasadena); Truran, J. W. Astrophys. J., 157: 339-65 (July 1969).

Synthesis of elements during thermonuclear burning of carbon is examined at a series of temperatures (T_9 = 0.6, 0.8, 1.0, 1.2, and 1.4) and for several initial compositions. Recent experimental results for the ($^{12}C + {}^{12}C$)-reaction are used. A general method for numerical solution of nuclear-reaction networks is described. At the higher temperatures in the range now thought to be appropriate for carbon burning in stars, $T_9 \gtrsim 1$, the Na/Mg ratio is similar to that of the Sun. At all temperatures considerable production of ^{20}Ne occurs. By using the results of the reaction-network calculations, a simple analytic expression for energy generation during carbon burning is constructed. Neutron exposures during carbon burning are presented for investigation of the s-process. (auth)

39128 LIMITS ON THE DENSITY AND TEMPERATURE OF MASSIVE SPHERES IN GENERAL RELATIVITY. Kovetz, A. (Tel Aviv Univ., Israel). Astrophys. J., 157: 335-7(July 1969).

A comparison of the maximal central pressure provided by gravity at the center of a star with the minimal pressure predicted on the exclusion principle brings out the existence of a critical mass. The central density in any star with a mass less than the critical mass is limited to two or more well-determined intervals, in agreement with known numerical results (e.g., Harrison et al., 1965). Similar limitations are obtained for the central temperature. No such limits exist for stars of supercritical mass. Stars of subcritical mass and high density, if they exist, must be remnants of supercritical masses. (auth)

39129 FINDING LIST OF EARLY-TYPE STARS IN REGIONS OF INTERMEDIATE GALACTIC LATITUDE. Upgren, A. R.; Staron, R. T. (Wesleyan Univ., Middletown, Conn.). Astrophys. J., 157: 327-34(July 1969).

A list is given of all stars of spectral class F2 and earlier, brighter than magnitude 11.5, found in four regions of intermediate galactic latitude. This objective-prism survey is part of a study of stellar densities aiming at the determination of the inclination to the galactic plane of surfaces of equal stellar density. The distribution of early stars fainter than 11.5, as well as other stars of later type, will be covered elsewhere. The conclusion is made that the stars included here do not appear to refute the model found by Oort but that the area covered is insufficient for a detailed analysis, as is also the case for other similar surveys cited. (auth)

39130 MK SPECTRAL TYPES FOR BRIGHT SOUTHERN OB STARS. Hiltner, W. A. (Univ. of Chicago); Garrison, R. F.; Schild, R. E. Astrophys. J., 157: 313-26(July 1969).

MK spectral classifications are provided for all OB stars south of −20° and earlier than B8 which are listed in the Catalogue of Bright Stars. (auth)

39131 SUBLUMINOUS STARS. III. LUMINOSITY CALIBRATION FOR SUBLUMINOUS STARS AND THE SPACE DENSITY OF THE BLUE SUBLUMINOUS STARS SOUTH OF DECLINATION −45°. Eggen, Olin J. (Australian National Univ., Canberra). Astrophys. J., 157: 287-311(July 1969).

The relatively large number of trigonometric parallaxes of white dwarfs now available, together with wide binaries containing a subluminous component and cluster parallaxes, makes possible a new calibration of the luminosities of subluminous stars. The tendency of these objects to form two sequences in the (M_V, U−V)-plane is confirmed and seems unlikely to be the effect of differential line blanketing alone. There is some confusion between the red subluminous stars and the M-type dwarfs with M_V near +10, especially among members of the Hyades Cluster. The possibility arises that some subluminous stars in Hyades, and in the field, represent stars with masses less than one-tenth the solar mass that have become degenerate without passing through the normal evolutionary process (Kumar's "black dwarfs"). Photometry of 158 stars south of declination −45° and called "probable white dwarfs" by Luyten shows these objects to be nearly equally divided between subdwarfs and subluminous stars. The resulting space density of blue subluminous stars is similar to that found from a larger sample of Lowell proper-motion stars discussed in Paper I and leads to a conservative estimate of 1.5×10^{-3} pc^{-3}. Identification charts are provided for the subluminous stars of declination −45°. (auth)

39132 THEORETICAL LINE INTENSITIES. VIII. COMMENT ON THE EFFECTIVELY THIN APPROXIMATION. Athay, R. Grant (High Altitude Observatory, Boulder, Colo.). Astrophys. J., 157: 281-5(July 1969).

The effectively thin approximation for the formation of spectral lines is discussed from the standpoints of photon-degradation processes and the random walk of scattered photons. It is shown that for some lines the optical thickness of the effectively thin layer is fixed by atomic rate coefficients and is independent of the model atmosphere. (auth)

39133 IDENTIFICATION, STRUCTURE, AND VARIATIONS OF NEW TiO BANDS IN THE ONE-MICRON SPECTRA OF MIRA VARIABLES. Lockwood, G. W. (Univ. of Virginia, Charlottesville). Astrophys. J., 157: 275-80(July 1969).

The identification of seven new TiO bands in the region λλ9725 to 10250 Å in 45 Å mm^{-1} image-tube spectra of Mira variables is discussed. The bands appear in stars later than M6, and they strengthen toward minimum light. Rotational structure is observed. A relationship between band strength and temperature is demonstrated. (auth)

39134 EFFECT OF AUTO-IONIZATION LINES ON THE OPACITY OF STELLAR INTERIORS. Watson, William D. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 157: 375-87(July 1969).

The contribution to the Rosseland opacity from auto-ionization lines is computed for an element mixture consisting of X = 0.74, Y = 0.24, and Z = 0.02. This contribution is found to be of roughly the same importance as that from normal lines at temperatures greater than about 5×10^5 °K. Under conditions that occur within stellar interiors, the contribution from auto-ionization lines often represents an increase of one-third to one-half in the total Rosseland opacity. The increase can be as great as 100% at some temperatures and densities. Although the Rosseland opacity is, in principle, sensitive to line shape, pressure broadening and overlap of lines destroy the details of line profiles when auto-ionization lines provide a significant contribution to the Rosseland opacity. It is found that the correct Fano profile can be replaced by the sum of the photoelectric and Lorentz absorption profiles that would exist in the absence of auto-ionization. The Mayer statistical approach is used in the treatment of all lines. Quantitative estimates for the sensitivity of the opacity to inaccuracies in the statistical parameters are made. Computations are performed at twenty temperature−density points. At these points, the following Rosseland opacities are presented: continuous, continuous plus normal line, continuous plus auto-ionization line, and total radiative. (auth)

39135 WHY THE TEMPERATURE RISE DOES NOT OCCUR IN RADIATIVE EQUILIBRIUM IN STELLAR CHROMOSPHERES OF DOMINANT H^- OPACITY. Jordan, S. D. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 157: 465-7 (July 1969).

It is demonstrated that the temperature inversion in the low solar chromosphere is very unlikely to result from the influence of the photospheric radiation field on the low-density gas. Therefore, dissipation of mechanical energy is necessary to produce the rise. Since this effect follows directly from the dominance of the continuum opacity by the H^- ion, the same conclusion follows for all stellar chromospheres where H^- dominates the continuum opacity. (auth)

39136 PHOTOMETRY OF MHα 328-116 II. Philip, A. G. Davis (New York State Univ., Albany. Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac., 81: 248-53(June 1969).

Photoelectric measures of MHα 328-116 obtained in September 1968 indicate that this peculiar, symbiotic object is still brightening, but at a slower rate than that observed in 1965. The observations are in agreement with the hypothesis that the He II (λ 4686) emission line is getting stronger, the hydrogen emission lines are getting weaker, and the continuum getting stronger. This object should be monitored photoelectrically and spectroscopically, since it may be approaching maximum light. (auth)

39137 Hα EMISSION-LINE STARS AROUND THE SCORPIUS OB 1 ASSOCIATION. Mac Connell, Darrell J. (Univ. of Michigan, Ann Arbor. Cerro Tololo Inter-American Observatory, La Serena, Chile); Perry, Charles L. Publ. Astron. Soc. Pac., 81: 259-64 (June 1969).

Tabular data and a finding chart, copied from a direct photograph, are given for the subject stars. (L.M.T.)

39138 COMMENT ON THE NEBULOSITY ABOUT FG SAGITTAE. Henize, Karl G. (Manned Spacecraft Center, Houston, Tex.). Publ. Astron. Soc. Pac., 81: 274-5(June 1969).

The author contends that the recent paper by Roark (Publ. Astron. Soc. Pac., 80: 712(1968)) contains confusing statements concerning the discovery and the existence of the nebulosity about this star which should be corrected in view of the importance of this unusual object. (W.D.M.)

39139 NEW METALLIC-LINE A STARS. Markowitz, Allan H. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware). Publ. Astron. Soc. Pac., 81: 275-7(June 1969).

During the course of an investigation of bright stars with composite spectra, four metallic-line A stars were recognized. Spectral types and rotational velocities of the stars are listed. (W.D.M.)

39140 SPECTROSCOPIC BINARY 66 ANDROMEDAE. Abt, Helmut A.; Levy, Saul G. (Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac., 81: 280-3(June 1969).

Orbital elements are derived for this double-lined system consisting of two F4V stars having a period of 9.374 days. The system is probably not an eclipsing one. (auth)

39141 INTENSITY VARIATION IN Ca EMISSION IN AN MS STAR. Boesgaard, Ann M. (Univ. of Hawaii, Honolulu). Publ. Astron. Soc. Pac., 81: 283-5(June 1969).

The purpose of this note is to report the presence of fairly strong Ca II emission at H and K in the spectrum of HD 30959, an M3S star. The measured intensity of the calcium emission relative to clear plate is about 40% of the continuum intensity. (W.D.M.)

39142 HIGH-VELOCITY INTERSTELLAR GAS. Dieter, Nannielou H. (Univ. of California, Berkeley). Publ. Astron. Soc. Pac., 81: 186-223(June 1969).

Recent observations that reveal the presence of high-velocity gas in a variety of forms and locations are discussed. These include both H II regions and H I regions. For the H II regions, internal and peculiar motions are described along with the remarkable velocities found in the associated interstellar molecular spectra. For the H I regions, particular emphasis is given to observations of neutral atomic hydrogen both in the galactic plane and that far from the plane. New results are presented for regions of high-latitude, high-velocity hydrogen. A discussion of theories for the origin of such gas is included. (auth)

39143 DYNAMICAL STUDY OF AN H II REGION. Sofia, Sabatino (Inst. for Space Studies, Goddard Space Flight Center, N. Y. Univ. of South Florida, Tampa). Publ. Astron. Soc. Pac., 81: 265-9(June 1969).

A study of the "equilibrium region" left behind the expanding ionization front in an H II region is performed in order to investigate the influence of the usually neglected dynamical effects in the structure of the region. To that effect, a 40,000°K star surrounded by an H II region with an initial electron temperature of 10,000°K and an initial electron density of 100 is considered. The gas is allowed to heat up, cool down, and move according to general hydrodynamic equations. It is found that after about 15,000 years the gas has relaxed to the same temperature found by the static treatment, and that while small velocities (due to the gravitational attraction of the star) and density differences have developed, they are not significant. In consequence, a static treatment for the "equilibrium region" is perfectly adequate, unless one is looking for transient effects of a time scale below about 15,000 years. (auth)

39144 THE 1968 PALOMAR SUPERNOVA SEARCH. Zwicky, F.; Sargent, W. L. W.; Kowal, C. (Carnegie Institution of Washing-

ton, D. C. California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac., 81: 224-9(June 1969).

Seventeen supernovae were found at Palomar during 1968. Photographs and a table listing the properties of each supernova are given. (W.D.M.)

39145 IS THERE NbO IN S-TYPE STARS? Davis, D. N. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Keenan, P. C. Publ. Astron. Soc. Pac., 81: 230-7(June 1969).

The bandheads of λ 6495 and λ 6154 are not useful for determining the presence of NbO because of their almost exact coincidence with bands from the lowest level of the ZrO molecule. More detailed study is needed to decide about the heads at λ 4688 and λ 6737. Plates obtained during cooler phases would be especially useful (and hard to get!). On certain R Cyg plates, namely, when the star was cooler, there is some evidence for the presence of the NbO bands at λ 6484 and λ 6591. There is no convincing evidence of NbO in any of the other S-type stars which could be studied. (auth)

39146 OBSERVATIONAL ASPECTS IN SUPERNOVA ASTRONOMY. Rudnicki, Konrad. Postepy Astron., 17: 99-121 (June 1969). (In Polish).

A supernova is any short-time existing, bright point object with an absolute magnitude in maximum $M < -11^m$. There are 5 main types of supernovae, and besides, some peculiar objects that perhaps are representatives of other types. The frequency of supernovae outbursts seems to depend on the nature of the parent galaxies and parent cluster of galaxies, but the available observational data are too scarce for a statistical analysis. This is especially true in the case of photometric data. More homogeneous methods of supernovae search are proposed. The present development of supernova research reveals relations between these objects and cataclysmic processes in the evolution of galaxies. (auth)

39147 OUTBURSTS OF NOVA DELPHINI 1967 (equals HR Del). III. PHOTOELECTRIC OBSERVATIONS AT ONDREJOV IN 1968. Grygar, J.; Kohoutek, L. (Astronomical Inst., Ondrejov, Czech. Astronomical Inst., Prague). Bull. Astron. Inst. Czech., 20: 156-7(1969).

Photoelectric observations of HR Del in 1968 are summarized in tabular form. The average rms errors per single observation were ±0.015 m, ±0.007 m, and ±0.009 m for V, B−V, and U−B, respectively. (W.D.M.)

39148 EVOLUTION OF CLOSE BINARIES. IV. CASE B OF MASS EXCHANGE FOR BINARIES OF MODERATE MASS. Kriz, S. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 20: 127-33(1969).

Computed is the evolution of a close binary consisting of components $13.8R_\odot$ apart having the masses $5M_\odot + 4M_\odot$, respectively. During the period of hydrogen burning, the primary component fills the Roche lobe, and a rapid mass transfer between the components causes the primary to lose 86% of its original mass. The remnant of the primary, whose mass is $0.7M_\odot$, contracts towards the helium main sequence, while the original secondary component becomes a main-sequence star with the mass $8.3M_\odot$. The distance between the components increases to $167R_\odot$. It is shown that, in moderate-mass binaries ($4M_\odot$ to $9M_\odot$), the mass exchanges in two phases, a rapid and slow one. The mass transfer may only terminate if the primary has completely lost its hydrogen-rich envelope. The only exception is binaries with long initial periods, in which hydrogen may start burning as early as in the rapid phase of mass transfer. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 39095, 39121, and 39256.

39149 PULSAR EMISSION MECHANISM. Michel, F. C.; Tucker, W. H. (Rice Univ., Houston, Tex.). Nature (London), 223: 277-9(July 19, 1969).

The object of this communication is to propose a mechanism for pulsar radiation which fits the pulsar NP 0532 associated with the Crab Nebula, based on association of the radiation with surfaces of zero radial flux in the pulsar magnetosphere. It is shown, on the basis of the model described, that a certain part of the energy loss is in the form of pulsed, linearly polarised, low frequency electromagnetic radiation. Most of the energy loss is initially in the form of outflowing magnetised plasma, but conditions are established for a pulsed radiation field. A shock transition must exist at some large radial distance to slow the flow to submagneto-acoustic velocities in response to the surrounding medium. The intersection of each zero flux sheet with the shock transition causes the surface currents to undergo rapid changes in velocity and magnitude, and the shock-neutral sheet interaction should be a source of pulsed electromagnetic radiation. The pulsed radiation output is insensitive to the location of the shock, which would be expected to be many AU from the pulsar. The question of moments of inertia is discussed. (UK)

39150 MASS LOSS FROM PULSATING NEUTRON STARS. Stothers, R. (Goddard Space Flight Center, N. Y.). Nature (London), 223: 279-80(July 19, 1969).

A new possibility is put forward involving radial pulsations of a neutron star which is undergoing mass loss, with a view to interpreting the observed period, and secular increase of period, of the Crab Nebula pulsar, NP 0532. It is shown that if sufficient mass loss occurs the radius of a pulsar, and therefore its period, may be increased. The mechanism of mass ejection is regarded as involving shock waves induced by the development of steepening progressive waves arising from the interior pulsations. The reason for the decrease of the rate of mass loss with time is related to change in structure. The increasing period will reduce the pulsational energy and therefore the means by which the star releases stored-up energy, and because the mechanism of mass ejection is expected ultimately to depend on the release of stored-up energy from the interior, the rate of mass ejection will also decrease in time. Mechanical work must be done to lift the ejected matter out of the gravitational potential well of a neutron star, and this requires an expenditure of about 10^{39} ergs/sec, depending somewhat on the mass of the star. This value is much larger than the rate of energy flow from the surface. The total required energy store is given by the sum of the work done in secularly expanding the star as a whole and in lifting matter out of the potential well, and at least 10^{50} ergs of nonthermal energy are required to maintain the mass outflow from the surface. Pulsational energy alone cannot be the source of mass loss, since the required radius amplitude is unacceptably large, although pulsational energy would have been relatively much more important at an earlier epoch. Nuclear sources of energy are also discussed. It is also possible that the necessary energy may be stored in magnetic fields, which are expected to be present in great strength in neutron stars, and hydromagnetic oscillations may release some of this energy in the form of mass loss. It is also possible that still other mechanisms of mass loss could be found to provide for the necessary secular increase of the neutron star radius. A few remarks are included concerning the original mass loss occurring in supernova events. (UK)

39151 PULSED X-RAY EMISSION OF NP 0532 IN MARCH 1968. Boldt, E. A.; Desai, U. D.; Holt, S. S.; Serlemitsos, P. J.; Silverberg, R. F. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London), 223: 280-1(July 19, 1969).

A measurement of the pulsed x-ray emission associated with the pulsar NP 0532 in the Crab Nebula is reported. The data were obtained with a six-element detector flown on an Aerobee 150 rocket from White Sands, New Mexico, at 0315 UT. It is stated that the measurement could provide information concerning the history of NP 0532 before its discovery in the radio and optical bands. Since the energy output of this object is generally considered to have its origin in the dissipation of rotational energy, knowledge of the period of pulsation is of special interest. The experimental technique adopted is described, and the observed "light curve" in the energy band 2 to 10 keV during the time 0317 to 0319 UT is shown. The expected period of 33.0855 ms was confirmed. It was estimated that the pulsed x-ray emission represented 15 ± 3% of the total x-ray flux from the nebula, a value not in agreement with that of other workers. It is suggested that the pulsed component of the x-ray emission may be variable in amplitude. The overall results indicate the possibility of a long term (1 yr) decrease in the pulsed x-ray emission and/or shorter term variability. (UK)

39152 SEARCH FOR OPTICAL FLASHES FROM PSR 0833-45. Willstrop, R. V. (Cambridge Observatories, Eng.). Nature (London), 223: 281-2(July 19, 1969).

A search was made on the nights of March 17 to 20th, 1969, using the 74-inch Radcliffe telescope, with a pulse-counting photometer and multichannel analyser. Results were negative, and confirmed earlier results. (UK)

39153 PULSARS AND THE MASS SPECTRUM OF COSMIC RAYS. Gold, T. (Cornell Univ., Ithaca, N. Y.). Nature (London), 223: 162(July 12, 1969).

In view of the possibility that pulsars generate relativistic gas which includes perhaps all or most of the cosmic rays, there is a new interest in the mass spectrum of cosmic-ray primaries. The cosmic-ray beam may contain detailed evidence of origin in neutron stars, in the form of fine detail in the relative abundance of a large number of nuclear species, and attempts to measure the mass and charge spectrum have a new significance,

through which it may be possible to verify the pulsar hypothesis. (UK)

39154 RADIO OBSERVATIONS OF THE NEBULAE K 3-50 AND NGC 6857. Rubin, Robert H.; Turner, Barry E. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 157: L41-4(July 1969).

Observations of the high-frequency continuum in the direction of the nebulae NGC 6857 and K3-50 show that the peak of emission coincides with K3-50, generally believed to be a planetary nebula. Radio recombination lines and OH emission were measured, neither previously detected in a planetary nebula. It is necessary to conclude that the classification of the object is uncertain and that it is possibly a small "compact" H II region, in which case the object remains unique, since it would be the first to have an optical counterpart. (auth)

39155 PHYSICAL PROPERTIES OF THE RADIO-EMITTING REGION IN SCO XR-1. Riegler, G. R. (Univ. of Maryland, College Park); Ramaty, R. Astrophys. Lett., 4: 27-31(July 1969).

On the basis of recent observations, it is deduced that the radio emission from Sco XR-1 is synchrotron radiation of relativistic electrons in an extended low-density region surrounding a denser core which produces the x-ray and optical continua. The linear dimensions of the radio-emitting region are larger than about 10^{12} cm, the ambient density is less than about 10^{9} cm^{-3} and the radiation could typically be produced by electrons of about 15 MeV in a magnetic field of a few gauss. (auth)

39156 OPTICAL OBSERVATIONS OF THE CRAB NEBULA PULSAR. Wampler, E. Joseph; Scargle, Jeffrey D.; Miller, Joseph S. (Univ. of California, Santa Cruz). Astrophys. J., 157: L1-10(July 1969).

Optical observations of the pulsar NP 0532 show that the shape of the light curve was constant to a high degree of accuracy on three nights distributed over a 10-day interval; the shape also is in excellent agreement with a detailed curve reported by Warner, Nather, and MacFarlane. Light curves obtained in the infrared (~7400 Å) and ultraviolet (~3700 Å) are closely similar to each other. Detailed measurements of linear polarization as a function of phase show (1) that the percentage polarization is a minimum near the peaks of the main and secondary pulses and increases in the wings and (2) that the position angle rotates rapidly and in the same sense during both main and secondary pulses. A simple geometrical model consisting of a rotation axis inclined 77° to the line of sight and a "polarization axis" located in or near the rotational equatorial plane is shown to fit the polarization data well. An upper limit of approximately 10% is obtained for the amount of circular polarization of the main and secondary pulses. (auth)

39157 SPECTROSCOPIC OBSERVATIONS OF THE PULSAR NP 0532. Lynds, R. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 157: L11-12(July 1969).

New spectroscopic observations are presented that reaffirm the absence of discrete spectroscopic features for the optical pulsar NP 0532. For some of the spectrograms a special technique was employed that permits phase resolution of the spectra of the main pulse and interpulse. This resolution in phase makes it possible to place an improved upper limit on the strengths of spectroscopic features. (auth)

39158 DISTRIBUTION OF AMMONIA DENSITY, VELOCITY, AND ROTATIONAL EXCITATION IN THE REGION OF SAGITTARIUS B2. Cheung, A. C. (Univ. of California, Berkeley); Rank, D. M.; Townes, C. H.; Knowles, S. H.; Sullivan III, W. T. Astrophys. J., 157: L13-20(July 1969).

Examination of 1.25-cm NH_3 inversion radiation in the Sgr B2 region shows an irregular distribution of NH_3 about 10′ in size, with considerable variation in density, velocity, and state of excitation. Relative intensities of the (1,1), (2,2), and (3,3) inversion transitions do not appear to correspond to equilibrium conditions. Relaxation processes, which allow nonequilibrium, are examined. (auth)

39159 INTERSTELLAR ABSORPTION OF 10-A X RAYS. Rappaport, S.; Bradt, H. V.; Mayer, W. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 157: L21-5(July 1969).

Measurements of the 10-Å flux of x rays from sources in the Scorpio–Sagittarius region give clear evidence for interstellar absorption, with a column density of at least 1×10^{22} H atoms cm^{-2}. In contrast, the x-ray flux from the Crab Nebula shows no evidence for a cutoff down to 12 Å (1.0 keV). This yields an upper limit for the average gas density between the Earth and the Crab Nebula of 0.5 H atom cm^{-3}. (auth)

39160 178-MHz OBSERVATIONS OF GALACTIC RADIO SOURCES. Holden, D. F.; Caswell, F. L. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 143: 407-35(1969).

High resolution observations at 178 MHz were used to investigate 45 radio sources in the region $|b^{II}| < 10°$, covering approximately the longitude range $30° < l^{II} < 60°$. The flux densities and angular structures were determined and, combined with other data, indicate the nature of many of the sources. Most of the sources are galactic and many of those classified as supernova remnants had not previously been recognized as such. (auth) (UK)

39161 THE VARIATIONS OF THE ELECTRON DENSITY WITHIN M8. Meaburn, J. (Univ. of Manchester, Eng.). Astrophys. Space Sci., 3: 600-14(Apr. 1969).

The ratios of the brightnesses of the [O II] lines at 3729 and 3726 Å were measured at 37 positions across M8. A multiple shell model was then constructed to estimate the large-scale variations of this ratio within the nebula. The amplitude and scale of the microscopic fluctuations of the electron density were then estimated by comparing these corrected [O II] measurements with previous radio observations of the rms electron density. It is concluded that the ionized matter in M8 is condensed to within approximately 0.025 of the volume occupied by the nebula. (auth)

39162 21-cm OBSERVATIONS AT LOW LATITUDES IN THE DIRECTION OF THE GALACTIC CENTRE. d'Odorico, S.; Sancisi, R.; Simonson III, S. C. (Leiden Observatory). Astron. Astrophys., 1: 131-8(Feb. 1969).

Observations of the 21-cm line of H I were made with the Dwingeloo 25-m radio telescope on a 0.5° grid between $l^{II} = -4.0°$ and $+2.0°$ and $b^{II} = +0.5°$ and $+5.0°$ between velocities $V = -100$ and $+90$ km/s. Maps of contours of brightness temperature T_b are given in l–V and b–V coordinates. Two small emission features are described: (1) a concentration covering one square degree at $l^{II} = -1.5°$, $b^{II} = +4.5°$, $V = -36$ km/s, with central $T_b = 6.6$°K and mass 320 r^2 $M_\odot$, where the distance r is in kpc, and (2) a stronger concentration covering four square degrees at $l^{II} = -3.5°$, $b^{II} = +2.0°$, $V = -20$ km/s, with central $T_b = 30$°K and mass 4300 r^2 $M_\odot$. Hydrogen self-absorption occurs over most of the region at $V = +4$ to $+8$ km/s. A concentration of cool hydrogen with spin temperature $T < 70$°K is found at $b^{II} = +2.5°$, $l^{II} < -2.0°$, and a region of $T < 55$°K is found at the position of the dark cloud near θ Ophiuchi. (auth)

39163 ELECTRON TEMPERATURES IN H II REGIONS. Louise, R.; Monnet, G. (CNRS, Marseille). Astron. Astrophys., 1: 153-5(Feb. 1969). (In French).

A high-resolution interference method was used to measure the profiles of the H_α ($\lambda = 6563$ Å) and [N II] ($\lambda = 6584$ Å) lines in some H II regions located in the Sagittarius arm (M 8, M 16, M 17, and M 20); from this, electron temperatures and internal turbulence were derived. Electron temperatures are always less than 7000°K in good agreement with radioastronomical results, except in M 16 where a high temperature (11,000°K) is found probably connected with a strong ionization front. (auth)

39164 POLARIZATION MEASUREMENTS WITH THE NANCAY RADIOTELESCOPE. DETECTION OF CIRCULAR POLARIZATION IN QSS AT 2695 Mc/s. Biraud, Francois (Observatoire, Meudon, France). Astron. Astrophys., 1: 156-63(Feb. 1969). (In French).

Focal antennas and receivers of the Nançay radiotelescope were designed to measure the complete state of polarization of incoming waves. Four parameters are measured, the horizontal and vertical components of the flux density, and their products, in phase and through a quarter-wavelength delay. Instrumental effects are: (i) cross polarization, which is not very high (~1%) because of the low-aperture ratio of the telescope (1,4), (ii) coupling between horizontal and vertical polarizations, through the polarization separator that follows the focal antenna, and (iii) variations of efficiency with declination. The ratio of horizontal and vertical efficiencies was determined by observing calibration sources, but not accurately enough to improve existing measurements of linear polarization. It is shown that the reduction of instrumental effects takes the form of a matrix relation between observed and true polarization parameters. Three independent series of measurements were obtained at 2695 MHz between March and July, 1968. 19 sources were measured, including 11 QSS. The results are in good agreement with previous ones at Caltech and Parkes. Nevertheless significant circular polarization was observed on two sources, a third case (3C 286) being doubtful because of intense linear polarization. But VRO 422201, recently identified with a variable stellar object, showed 1% left-hand circular polarization, that disappeared during a strong increase in flux density. It may be a QSS. PKS 1127-14, which is a QSS, shows about 2% left-hand circular polarization, that seems constant. These two sources have very similar peaked spectra. (auth)

39165 SEARCH FOR ULTRA-SHORT LIGHT PULSES FROM PULSARS. Oegelman, H.; Sobieski, S. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London), 223: 47-8(July 5, 1969).

Reference is made to studies of light pulses from the pulsars CP 1133, NP 0532, and NP 0527 using night sky Cherenkov light detectors. Measurements of angular distribution of intensity for the latter two pulsars supported the view that the nanosecond light pulses originate directly from the pulsars, rather than indirectly through high-energy primary photons. Studies are described with a view to testing the intrinsic source hypothesis. A program of photometric observations was conducted with the 36-inch optical telescope at the Goddard Space Flight Center; details of the experimental setup are given. Results argued strongly against optical pulses of nanosecond duration originating directly in these pulsars. (UK)

39166 LOW-ENERGY COSMIC RAYS FROM PULSAR FLARES? Feldman, P. A.; Silk, J. I.; Schwartz, R. A. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Nature (London), 223: 48-9(July 5, 1969).

It is stated that the remarkable and unexpected increase in the pulsation rate of PSR 0833-45 could be of importance in connection with the possible role of pulsars in the production of cosmic rays, and an estimation is made of the low-energy cosmic-ray density in the Galaxy due to pulsar flares. A single event of the type shown by the Vela pulsar might be expected to produce about 2×10^{46} ergs of 50-MeV cosmic rays, and it is calculated that pulsar flares could produce an energy density of ~0.5 eV cm^{-3} in ~50-MeV cosmic rays. Observations of cosmic rays, and arguments based on heating requirements and observed properties of the interstellar medium, indicate a low-energy cosmic-ray energy density of 0.1 to 1 eV cm^{-3}, and only ~300 pulsar flares per year throughout the Galaxy, of the magnitude surmised to have occurred in the Vela pulsar, are needed to account for this intensity of low-energy cosmic rays. (UK)

39167 H I CONCENTRATION AT LATITUDE +69°, LONGITUDE 103°. Wesselius, P. R. (Kapteyn Astronomical Observatory, Groningen, Netherlands). Astron. Astrophys., 1: 476-8 (Apr. 1969).

A neutral hydrogen cloud at latitude +69, longitude 103° is described. Over a region of 3° diameter the velocity of the top intensity is +29 ± 0.5 km/s. At points of highest intensity the dispersion is smallest (≲2 km/s). The distance may be r = 100 to 1000 pc, the age 16^6 to 10^7 years; the hydrogen mass is 2.6×10^{-6} r^2, the density [(6×10^3)/r] [r in pc]. (auth)

39168 FIVE-COLOR PHOTOMETRY OF THE X-RAY SOURCE Sco X-1. van Genderen, A. M. (Leiden Observatory). Astron. Astrophys., 2: 6-17(May 1969).

Photoelectric five-color observations of the x-ray source Sco X-1, made in 1966, 1967, and 1968 are discussed. A period of 0.5276^d could be found to which the majority of the observations obey more or less. The mean light curve shows the characteristic shape of a pulsating star. Often the star remains bright during the predicted minimum and shows flare activity. The general behavior of the color changes is that the star is blue at maximum and red at minimum light. (auth)

39169 PROPERTIES OF INTERSTELLAR CLOUDS AND THE INTERCLOUD MEDIUM. Hjellming, R. M.; Gordon, C. P.; Gordon, K. J. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. Astrophys., 2: 202-8(June 1969).

Quantitative models of interstellar H I regions are discussed in the context of heating and ionization of both interstellar clouds and an inter-cloud medium by low-energy cosmic rays. It is shown that, if the clouds are in pressure equilibrium, then the temperatures, neutral hydrogen densities, and electron densities for both the clouds and the inter-cloud medium are uniquely related. Data concerning the lines of sight to the pulsars NP 0532, CP 0328, and PSR 1749-28 are used to determine the properties of the intervening clouds and the inter-cloud medium. The results support cloud temperatures of about 50°K, inter-cloud temperatures of roughly $10^{3.8}$°K, and $(2.5 \pm 0.5) \times 10^{-15}$ cosmic-ray ionizations per hydrogen atom per second. (auth)

39170 INTERPLANETARY SCINTILLATIONS OF RADIO-SOURCES AT 2695 MHz. Bourgois, G. (Observatoire, Meudon, France). Astron. Astrophys., 2: 209-17(June 1969). (In French).

The interplanetary scintillations of nine radio sources were observed at Nançay on the wavelength of 11 cm. The observations were made simultaneously on the horizontal and vertical polarizations. The data processing in real time consisted in the determination of the rms of the scintillations as well as their cross-correlation coefficient. Strong and weak regimes were seen in the scintillations. The cross-correlation coefficient was, within the error limits, equal to one. A total scintillation index was defined and the variations of the scintillation index versus solar elongation were analyzed for four sources: CTA 21, P 1148-00, 3C 273, and 3C 279. The rms phase deviation ϕ_0 introduced by the solar corona was evaluated from P 1148-00 whose scintillation index reaches 90%. With some assumption, the mean angular distance between the three components of 3C 273 and 3C 279 were found. On October 12 and 13, 1968, enhanced scintillations of 3C 279 were observed. (auth)

39171 X-RAY SPECTRAL DATA FROM GX3 +1. Gorenstein, P.; Giacconi, R.; Gursky, H. (American Science and Engineering, Cambridge, Mass.). Astrophys. J., 157: 463-4(July 1969).

X-ray spectral data in the region 1 to 8 keV are presented for GX3 + 1, a source which has been identified with an emitter of harder x rays in the Sagittarius–Scorpio region. (auth)

39172 MODELS OF X-RAY STARS. Manley, Oscar P. (American Science and Engineering, Cambridge, Mass.); Olbert, Stanislaw. Astrophys. J., 157: 223-46(July 1969).

A radiation instability, peculiar to bounded, optically thin magnetoactive plasmas, is assumed to engender fluctuations in the magnetic field. The fluctuations are shown to lead to a variant of the Fermi acceleration mechanism, which produces hard spectra of electron energies. A theory of galactic x-ray sources, based on this mechanism, appears to account for all the known and inferred properties of the x-ray star Sco X-1. (auth)

39173 OBSERVATIONS OF X RAYS FROM TAURUS X-1 AND CYGNUS X-1. Glass, I. S. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 157: 215-22(July 1969).

Measurements of the intensity and spectral distribution of high-energy x rays from the Crab Nebula and Cyg X-1 were made on October 2, 1967, using a 5000 cm^2 balloon-borne proportional counter array. Both spectra can be represented by power laws of the form $dN/dE = k(E/E_0)^{-\alpha}$ over the observed energy range from 20 to 70 keV. For the Crab Nebula, k and α have the approximate values 0.0068 cm^{-2} sec^{-1} keV^{-1} and 2.16, respectively, with E_0 = 30 keV. The corresponding values for Cyg X-1 are 0.008 and 1.8, with E_0 = 30 keV. The ratio of intensities Cyg X-1/Tau X-1 is 1.2 ± 0.1 in the range considered. The upper limit on the intensity of any spectral line near 60 keV is 3×10^{-3} cm^{-2} sec^{-1} for Tau X-1 and 4×10^{-3} cm^{-2} sec^{-1} for Cyg X-1. (auth)

39174 X-RAY SPECTRA OF SEVERAL DISCRETE COSMIC SOURCES. Meekins, J. F.; Henry, R. C.; Fritz, G.; Friedman, H.; Byram, E. T. (Naval Research Lab., Washington, D. C.). Astrophys. J., 157: 197-213(July 1969).

Spectra of Sco XR-1, Cyg XR-1, and Cyg XR-2 were derived for the photon energy range of 1.5 to 13 keV from proportional-counter measurements made on September 8, 1967. The spectrum of Sco XR-1 may be described by bremsstrahlung with a temperature of $(65 \pm 5) \times 10^6$ °K. No simple power-law (synchrotron) spectrum is consistent with this observation. Iron line radiation, if present, must be less than 5% of the total emission in the (1.5 to 13)-keV region. The spectrum of Cyg XR-1 may be fitted by an energy power law of index 1.4 or 1.5; that of Cyg XR-2, by bremsstrahlung with a temperature of $(60 \pm 10) \times 10^6$ °K. (auth)

39175 TEMPERATURES AND OH OPTICAL DEPTHS IN DUST CLOUDS. Heiles, Carl (Univ. of California, Berkeley). Astrophys. J., 157: 123-34(July 1969).

OH microwave-line optical depths and excitation temperatures were measured in five dust clouds. Optical depths in the 1667-MHz line range downward from 2.2; excitation temperatures are 4.5°K in one cloud and 5.4°K in another; lower limits of 4.7° and 9.6°K were established in two more. Expected values of kinetic and OH excitation temperature were calculated for various values of cosmic-ray intensity and free-atom density in dust clouds. For each cloud two values of density are consistent with observations—e.g., either (roughly) 10^3 or 10^{-3} atoms/cm^3—and no definitive observational evidence exists supporting one case or the other. Several tests are proposed, including measurements of optical absorption lines and low-frequency radio absorption. It is thought that the high-density solutions are correct, in which case the kinetic temperature is equal to the OH excitation temperature, and the clouds are unstable to gravitational contraction. OH line widths then indicate contraction velocities of ≳1 km sec^{-1}. (auth)

39176 POLARIZATION MEASUREMENTS OF EXTRAGALACTIC RADIO SOURCES AT 3.12-CM WAVELENGTH. Berge, G. L.; Seielstad, G. A. (California Inst. of Tech., Pasadena). Astrophys. J., 157: 35-43(July 1969).

The two-element interferometer at the Owens Valley Radio Observatory was used in late 1967 to measure the integrated polarization, both linear and circular, of thirty-two extragalactic radio sources at a wavelength of 3.12 cm. In addition, flux densities of 103 radio sources were also measured. There is a tendency for

sources with inverted spectra at wavelengths between 11 and 3 cm to have inverted depolarizations in this range as well. No detection of circular polarization was made. (auth)

39177 THE SPECTRA OF RADIO SOURCES IN THE REVISED 3C CATALOGUE. Kellermann, K. I. (National Radio Astronomy Observatory, Green Bank, W. Va.); Pauliny-Toth, I. I. K.; Williams, P. J. S. Astrophys. J., 157: 1-34(July 1969).

Accurate values of the flux density are given for nearly all sources in the Revised Third Cambridge Catalogue at frequencies of 38, 178, 750, 1400, 2695, and 5000 MHz. These have been used to determine the spectrum of each source over this frequency range. It is concluded that the form of the spectra in many sources is determined not only by the energy distribution of relativistic electrons but also, as a result of self-absorption, by their spatial distribution. Sources identified with quasi-stellar objects have a wider dispersion of spectral indices than those identified with radio galaxies, particularly at the higher frequencies. Among the radio galaxies, the intrinsically strongest sources appear to have the steepest spectra. Unidentified sources have steep spectra similar to those of the stronger radio galaxies, and they are probably distant galaxies. (auth)

39178 OBSERVATIONS OF SATELLITE-ANOMALOUS OH EMISSION SOURCES. Turner, Barry E. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 157: 103-22(July 1969).

The Class II OH sources W28, W41, W43, W44, and Cas A differ from the Class I sources (W3, W49, NGC 6334, etc.) by showing anomalous emission and absorption only in the satellite lines, but normal absorption in the main lines. The spatial distribution and Stokes parameters of these Class II OH sources as well as of W33 and a new source W28 (A_2) were observed; the results show that emission typically arises from more than one region within a source (W28, W44, W43), or that it may be extended (W43, Cas A) and that several features [in W28(A_2), W43, and Cas A] may not be physically associated with the continuum source at all. The polarization of emission features in the satellite lines of Class II sources is small, while that in the main lines of the other sources [W28(A_2), W33] is nearly always much larger than for satellite lines, although their amplitudes may actually be smaller. Evidence of time variations in W33 and Cas A is presented. (auth)

39179 PULSARS, NEUTRON STARS, AND COSMIC RAYS. Ruderman, M. Comments Nucl. Particle Phys., 3: 37-41 (Mar.-Apr. 1969).

The supernovae process is briefly reviewed and the neutron star resulting therefrom is discussed. The evidence in favor of the neutron-star hypothesis of pulsars is presented. The pulsars as the source of cosmic radiation are discussed. (W.D.M.)

39180 PULSARS. Good, Myron L. (State Univ. of New York, Stony Brook). Comments Nucl. Particle Phys., 3: 75-7 (May-June 1969).

A very brief discussion is presented on the pulsing mechanisms for pulsars. Models specifically mentioned include Chiu, Eastlund, Gold, and Good. (W.D.M.)

Solar Phenomena

Refer also to abstracts 39346, 39347, 39350, 39452, and 40012.

39181 (NP-tr-1791) OBSERVATION OF THE BRIGHTNESS DISTRIBUTION AT 1216 A AND 1300 A AT THE SOLAR LIMB. Blamont, J. E.; Malique, C. (Centre National de la Recherche Scientifique, Verrieres-le-Buisson (France)). Translated for Culham Lab., Abingdon, Eng., from a report. 29p. (CTO-613). Dep. CFSTI.

Two photometers were mounted on board a sounding rocket for the observation of the total solar eclipse in the Argentine on 12th November, 1966. Observations started at an altitude of 120 km on the ascending part and ended at an altitude of 123 km on the descending part of the trajectory. The brightness distribution at the limb of the solar disc and in the chromosphere up to 12,000 km at 1216 and 1300 Å were determined with excellent relative accuracy. The geometric limb of the solar disc in this wavelength region is situated at an altitude of 2490 km in the chromosphere. An increase in brightness, or a bright ring, is observed at the limb of the disc with a total width of 18 seconds of arc at Lyman alpha and 6 seconds of arc at 1300 Å. (auth)

39182 EVOLUTION OF THE SOLAR SYSTEM. Woolfson, M. M. (Univ. of York, Eng.). Rep. Progr. Phys., 32: 135-86 (Apr. 1969).

A brief description of the solar system is given which highlights those features that a plausible theory should explain. A review of theories up to 1960 leads to a description of more modern work and also points out the major features for which explanations are difficult to find. The major obstacle, on which all the older theories founder, is the explanation of the distribution of angular momentum in the system whereby the planets with 0.14% of the mass possess 98% of the angular momentum. Another problem, which has been emphasized by Hoyle, is the slow rotation of the Sun, which is difficult to explain in terms of condensation from material possessing the basic galactic rotation. The modern theories described are: (1) Hoyle's nebula theory, which invokes the transfer of angular momentum by magnetic forces; (2) the accretion theory, which proposes that planetary material was captured by the Sun from an interstellar cloud; (3) McCrea's floccule theory, which describes the solar system as having formed from initial condensations of planetary mass; (4) the capture theory, which proposes that the Sun captured planets from a tidal filament drawn out of a light star; (5) a nebula theory proposed by Urey based on chemical evidence derived primarily from meteorites. (auth) (UK)

39183 MORPHOLOGY OF A SOLAR-TERRESTRIAL EVENT IN MARCH 1966. Ballif, J. R.; Jones, D. E. (Brigham Young Univ., Provo, Utah). J. Geophys. Res., 74: 3512-16(July 1, 1969).

The authors assumed the existence of a long-lived stream structure in the interplanetary magnetic field during late March 1966. The main feature of this stream was a uniform, high-field core that passed the Earth on March 24. The geomagnetic activity, anisotropy of solar particles over the energy range 0.6 to ~100 MeV/nucleon, and the anisotropy of the Forbush decrease, which were observed during the event, were analyzed and were all found to be compatible with the proposed stream structure. (auth)

39184 SOME FEATURES OF THE SOLAR MICROWAVE EMISSION AND THEIR CONNECTION WITH GEOMAGNETIC ACTIVITY. I. THE QUIET COMPONENT OF THE 9.1-cm EMISSION AND THE "M-REGIONS." Roosen, J. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Solar Phys., 7: 448-62(June 1969).

The quiet component of the 9.1-cm solar radio emission was studied from the Stanford radioheliograms covering the period April–October 1964. The distribution of the brightness temperature in heliographic coordinates was not entirely uniform, but positive and negative departures from the average value appeared at a number of stable locations. The most important negative departure crossed the central meridian 4 days before the maximum of the recurrent geomagnetic activity. Two out of three less important brightness depressions were connected with geomagnetic disturbances in the same manner. It is suggested that the brightness depressions are identical with M regions. The result was confirmed by the construction of polytrope models for the solar wind, for various values of the parameters α (the polytrope index) and T (the temperature in the inner corona). The velocities near the Earth's orbit and in the inner corona were computed as functions of the model parameters, the density resulted from the observed proton flux at 1 AU. For quiet conditions the model with $T = 1.26 \times 10^6$ K and $\alpha = 1.10$ was appropriate. The corresponding density and temperature in the corona led to a value of 4000°K for the contribution of the corona to the 9-cm brightness. For disturbed conditions the suitable model had the parameters $T \approx 2.0 \times 10^6$ K, $\alpha \approx 1.04$. It being given that the proton flux at 1 AU was relatively constant, the equation of continuity leads to a low coronal density because of the high solar-wind velocity. The corresponding coronal contribution to the 9-cm brightness was of the order of 10°K. This confirmed that the brightness temperature was considerably reduced in the regions where the enhanced solar wind originates. The name "coronal depression" for such regions is suggested. (auth)

39185 GAS FLOW DUE TO SOLAR FLARES. Korobeinikov, V. P. (Univ. of Newcastle-upon-Tyne, Eng.). Solar Phys., 7: 463-9(June 1969).

A hydrodynamical description of the gas flow due to a solar flare is considered. Use is made of the model of a point explosion in a gas with a variable initial density, velocity, and pressure. (auth)

39186 EFFECT OF FINITE ELECTRICAL CONDUCTIVITY ON THE ANGULAR-MOMENTUM LOSS OF THE SUN DUE TO THE SOLAR WIND. Weber, E. J. (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys., 7: 470-7(June 1969).

In general the solutions to the azimuthal equations of motion of the solar wind possess a singularity at the radial Alfvénic critical point if the fluid is nonviscous and has an infinite electrical conductivity. This singularity can only be removed by a proper choice of boundary conditions. If a plasma with a large but finite conductivity is considered, the singularity is removed in the mathematical sense. However, it is shown that for this latter case the actual solution does not differ significantly from the former model and

that the boundary condition is still determined from the behavior of the solution at or near the Alfvénic critical point. (auth)

39187 COMPARISON OF THE PHOTOSPHERIC AND INTERPLANETARY MAGNETIC FIELDS DURING THE FLIGHT OF MARINER IV. Winters, John B.; Ballif, Jae R.; Jones, Douglas E. (Brigham Young Univ., Provo, Utah). Solar Phys., 7: 478-85 (June 1969).

The polarity of the interplanetary magnetic field observed by the Mariner IV spacecraft is compared to the polarity of the photospheric magnetic field observed with the solar magnetograph at Mt. Wilson Observatory. Unlike the results obtained from observations during the flight of IMP-I, these polarities are not well correlated when the photospheric polarity is determined from data along a narrow latitudinal strip. It is suggested that the structure of the interplanetary field is often related to major features in the photospheric field that are observed over a broad range of solar latitudes. (auth)

39188 ANISOTROPIES OF SOLAR COSMIC RAYS. Fisk, L. A.; Axford, W. I. (Univ. of California, San Diego, La Jolla). Solar Phys., 7: 486-98(June 1969).

The behavior of the anisotropy during solar cosmic-ray events is discussed in terms of a simple model in which cosmic-ray particles propagate along the mean interplanetary magnetic field, undergoing pitch-angle scattering. It is shown that a generalized form of the telegraph equation should be used when the anisotropy is large (i.e., greater than 30%), but that the usual diffusion equation is adequate otherwise. The behavior of the anisotropy during the decay phase of solar cosmic-ray events is then considered, and several effects which can give rise to a small persisting anisotropy are described. Finally, observations of solar cosmic-ray anisotropies following flares are reviewed and it is concluded that the simplified mathematical treatment presented here adequately describes some of the general features of the behavior of the anisotropy, but does not provide a detailed quantitative description of the particle behavior, especially during the highly anisotropic phase of an event. (auth)

39189 SOME PROPERTIES OF UMBRAL FLASHES. Wittmann, A. (Univ., Goettingen, Ger.). Solar Phys., 7: 366-9 (June 1969).

In a recent paper Beckers and Tallant (1969) reported on their observations of very short-lived Ca^+ emission features in the umbral chromosphere. They called them 'umbral flashes' and described quite a number of their properties. This note presents the results of both visual and photometric observations of umbral flashes on K-line filtergrams. (W.D.M.)

39190 DEPENDENCE OF FACULA–PHOTOSPHERE CONTRAST IN MOLECULAR LINES ON DISSOCIATION ENERGY. Pande, M. C.; Gaur, V. P.; Tripathi, B. M. (Uttar Pradesh State Observatory, Naini Tal, India). Solar Phys., 7: 370-6(June 1969).

Assuming local thermodynamic equilibrium and the same relative abundances to prevail both in photosphere and faculae, the concentration-optical depth curves for molecules CH, NH, OH, C_2, CN, and CO were obtained for the four combinations of two photospheric and two facular models and the relative excesses α of these molecules in the photosphere over those in faculae were calculated. The change of photospheric model significantly affects the relationship, for a given facular model, between α and D_0, the dissociation energy of the molecule concerned. Besides, the average depth of formation in the facular models and photospheric models shows a relationship with D_0. (auth)

39191 SOME STATISTICAL PROPERTIES OF SURGES. Westin, Hans (Swedish Astrophysical Station, Anacapri, Italy). Solar Phys., 7: 393-416(June 1969).

All surges observed at the Swedish Astrophysical Station in Anacapri from July 1, 1957 until December 31, 1967 were studied statistically. In 1958 the southern hemisphere was most active in producing surges, but thereafter the northern hemisphere has dominated the activity with increasing rate. The average for the whole period shows that the northern part of the Sun has been twice as active as the southern part. The latitude distribution for surges has varied with the solar cycle with a pattern similar to the butterfly diagram for sunspots. The polar surges were most frequent in the beginning of the new cycle. The importance distribution is also dependent on the solar cycle, as a higher percentage of surges of importance 1 are found during the solar minimum. Surges of higher importance tend to have longer durations, and they are more often associated with flares. The association rate between surges and radio emission is dependent on both the solar cycle and the importance of the surge. During years with high activity, more than 20% of all surges were followed within 5 min from their start by radio emission, compared to 4% during solar minimum. 17% of surges of importance 2 are closely related to radio emission, but only 10% of surges of importance 1. On the whole, 11% of the surges occurred almost simultaneously with radio bursts. Bursts in discrete frequencies were registered in connection with 8% of the surges, while 11% were followed within 5 min from their start by bursts in special observations. All these surges were isolated, i.e., no flares have been reported to occur during their lifetimes. This is also the case for the 18 surges covered by x-ray observations, three of which were closer related to x-ray bursts. (auth)

39192 BRIGHTNESS VARIATIONS OF THE WHITE-LIGHT CORONA DURING THE YEARS 1964–67. Hansen, Richard T. (National Center for Atmospheric Research, Kamuela, Hawaii); Garcia, Charles J.; Hansen, Shirley F.; Loomis, Harold G. Solar Phys., 7: 417-33(June 1969).

Observations of the white light corona were made on over 900 days during the years 1964–67 at heights between 1.125 and 2.0 $R_\odot$ with the K-coronameter at Mount Haleakala and Mauna Loa, Hawaii. The brightness distribution of the minimum corona was elliptical with average equatorial intensities three times the polar. Coronal features of the new cycle at 1.125 $R_\odot$ occurred predominantly in the sunspot zones at 25 to 30° latitude and in a high latitude zone which migrated toward the north pole before solar maximum. The brightness of the inner corona doubled over this period and a close association was found between the average corona and 10.7-cm solar radio flux. Electron densities in the equatorial regions were nearly twice those of Van de Hulst's model corona, in agreement with the results of recent eclipse observations. (auth)

39193 QUIET AND SLOWLY VARYING COMPONENTS OF 9.1-cm RADIO EMISSION DURING THE SOLAR MINIMUM. Riddle, A. C. (Stanford Univ., Calif.). Solar Phys., 7: 434-47 (June 1969).

Radio emission from the Sun at 9.1 cm was studied during 1964–65 using the Stanford spectroheliograph. A map of the quiet Sun was prepared and compared with a map produced using the same instrument in 1960. On the basis of ray tracing results the differences in the two maps can be explained by a decrease in the electron density by a factor of 1.4 at the equator and 1.1 at the poles. The slowly varying component of emission can be attributed to electron density enhancements by a factor of 2 to 5 over regions with dimension 2′ to 6′ arc. Changes of flux and width of these regions with longitude on the Sun agree with the results of ray tracing using a very simple model for the regions. The detection of sunspot groups on the far side of the Sun by measuring increased 9.1-cm emission at the limbs is shown to be possible. (auth)

39194 CHROMOSPHERIC INHOMOGENEITIES IN SUNSPOT UMBRAE. Beckers, Jacques M.; Tallant, Paul E. (Sacramento Peak Observatory, Sunspot, N. Mex.). Solar Phys., 7: 351-65 (June 1969).

The properties of rapidly changing inhomogeneities visible in the H and K lines above sunspot umbrae are described. Properties for these "Umbral Flashes" include: (a) A lifetime of 50 sec. The light curve is asymmetrical, the increase is faster than the decrease in brightness. (b) A diameter ranging from the resolution limit up to 2000 km. (c) A tendency to repeat every 145 sec. (d) A "proper motion" of 40 km/sec generally directed towards the pneumbra. (e) A Doppler shift of 6 km/sec. (f) A magnetic field of 2100 G. (g) A decrease in this field of 12-G/sec. This decrease is probably related to the flash motion. (h) At any instant an average of 3 to 5 flashes in a medium-sized umbra. A weak feature often persists in the umbra after the flash. This post-flash structure initially shows a blue shift, but 100 to 120 sec after the flash, it shows a rapid red shift just before the flash repeats. (auth)

39195 INTERPRETATION OF INFRARED OXYGEN SPECTROHELIOGRAMS. Altrock, Richard C. (Sacramento Peak Observatory, Sunspot, N. Mex.). Solar Phys., 7: 343-50(June 1969).

Spectroheliograms were obtained in the line cores of two infrared multiplets of neutral oxygen. Those made in the lines of the 7770 Å multiplet showed a very smooth intensity distribution, with faculae and sunspot penumbrae at a very low contrast with respect to the undisturbed photosphere. Spectroheliograms made in the core of λ 8446.37 Å showed evidence of coupling with chromospheric features and of blending with a line of neutral iron. An analysis of a λ 7772 Å spectroheliogram indicates that a magnetic field of approximately 1500 G is required to produce the "disappearing penumbra" phenomenon. This value is consistent with the recent observations of Beckers and Schröter (1969). (auth)

39196 DISCUSSION: INTERPRETATION OF POSITIVE ION MEASUREMENTS MADE BY THE ARC QUADRISPHERICAL ELECTROSTATIC ANALYZER ON PIONEER 6. Hund-

hausen, A. J. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res., 74: 3740-6(July 1, 1969).

In papers discussing solar-wind positive ion measurements made by the Ames (ARC) quadrispherical electrostatic analyzer on the Pioneer 6 spacecraft, Wolf et al. (1966), and Scarf et al. (1967), presented data showing that solar-wind ions arrive from different directions when observed at different energies. The "skewing" of the measured flux was interpreted as evidence for anisotropic thermal motions of the ions. Khoklov (1968) has called attention to inconsistencies in the estimates of the magnitude of the anisotropies implied by the ARC observations. It is the purpose of this Letter to point out that the ARC measurements of a skewed flux do not necessarily imply anisotropic distribution functions. A reply by Wolfe, Feldman, and Smith is included. (W.D.M.)

39197 UPPER LIMITS FOR HIGH-ENERGY NEUTRONS FROM TWO IMPORTANCE-1 SOLAR FLARES. Zych, A. D.; Frye, G. M. Jr. (Case Western Reserve Univ., Cleveland). J. Geophys. Res., 74: 3726-9(July 1, 1969).

The search for solar neutrons has included the possible detection of both a steady-state flux and bursts of neutrons associated with specific solar activity. Concern in this note is with neutrons resulting from the second possibility. Upper limits of 1.0×10^{-2} and 1.7×10^{-2} n/cm^2 sec, respectively, are reported for solar neutrons from two importance 1 solar flares at 1849 and 1935 UT during a balloon flight on July 28, 1967. (W.D.M.)

39198 FLARES, FORBUSH DECREASES, AND GEOMAGNETIC STORMS. Ballif, J. R.; Jones, D. E. (Brigham Young Univ., Provo, Utah). J. Geophys. Res., 74: 3499-3511(July 1, 1969).

The authors hypothesize that individual flares are not the cause of either Forbush decreases or geomagnetic storms. Evidence supporting this hypothesis is here presented showing that geomagnetic storms and Forbush decreases can be accounted for entirely by the effects of interplanetary "streams." Major cosmic-ray variations begin near the time that a flare-producing region on the Sun passes central meridian. This relationship and a similar relationship between geomagnetic storms and flare-producing regions is shown to exist even during the intervals that include the energetic flares that have produced ground-level increases in neutron monitor counts. Streams, closely associated with these flare-producing regions, are usefully described by the structure in the interplanetary magnetic field since fluctuations in the interplanetary field are highly correlated with the Kp index and the interplanetary field strength is inversely correlated with the cosmic-ray intensity. Such stream structure is used to account for the observed "center limb effect." It is also shown that when flares of importance 3- or greater occur within a few days of very high geomagnetic activity and at longitudes greater than 25° west, the major geomagnetic activity precedes the flare. This result is not easily explained by the hypothesis that periods of intense geomagnetic activity are due to individual flare effects. (auth)

39199 THE PROTON FLARE OF 9 JUNE 1968. Badillo, V. L. (Manila Observatory); Castelli, J. P. Astrophys. Lett., 4: 5-9(July 1969).

A small short-lived southern region on the Sun produced severe and unexpected geophysical effects. The history of the region is detailed. The U-shaped spectral signature of the cm-dm burst gave warning of a possible PCA. (auth)

39200 RELATIVE ABUNDANCE OF IRON-GROUP NUCLEI IN SOLAR COSMIC RAYS. Bertsch, D. L.; Fichtel, C. E.; Reames, D. V. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 157: L53-6(July 1969).

The abundance of the iron-group nuclei relative to oxygen in a solar cosmic-ray event was determined for the first time in the event of September 2, 1966; it was found to be $(1.1 \pm 0.3) \times 10^{-2}$ above 24.5 MeV nucleon^{-1}. This ratio is consistent with the solar value determined spectroscopically but is over an order of magnitude smaller than the galactic cosmic-ray ratio. This result is in agreement with the concept already evolving from measurements on other nuclei that the relative abundances of solar cosmic rays reflect those of the solar photosphere for multicharged nuclei with approximately the same nuclear charge-to-mass ratio. (auth)

39201 DIMENSIONS, TEMPERATURE, AND ELECTRON DENSITY OF THE QUIET CORONA: THEIR VARIATIONS DURING THE SOLAR CYCLE. Leblanc, Y.; Le Squeren, A. M. (Observatoire, Meudon, France). Astron. Astrophys., 1: 239-48(Feb. 1969).

Solar observations made using the Nançay interferometer at 169 MHz between January 1957 and December 1964 have allowed the determination of the dimensions, temperature, and density of the solar corona: the effects of solar activity (condensation, burst, storm center, etc.) have been eliminated. At the time of minimum solar activity the equatorial diameter was 38′ ± 1′ and the polar diameter 32′ ± 3′, representing an ellipticity of 0.84. The received flux density at this time was $6 \cdot 10^{-22}$ W m^{-2} Hz^{-1}, corresponding to a brightness temperature of 1.1×10^6°K. This temperature, calculated directly from the observed dimensions and the coronal emission, is one of the best estimates currently available, and may be considered equal to the electron temperature in the corona, which at this frequency is optically thick. At the time of maximum solar activity the equatorial diameter was 47′ ± 2′, but the polar diameter was not measured. The flux density was then 12.5×10^{-22} W m^{-2} Hz^{-1}. Oblate ellipsoidal and spherical corona models were calculated compatible with the observations. It is concluded that at solar minimum the temperature is 1.1×10^6°K and the electron density is given by $2.0 \times 10^{6+4.32/\rho}$. At solar maximum the best fitting model for the corona is an oblate ellipsoid at temperature of 1.8×10^6°K with a density of $0.83 \times 10^{6+2.64/\rho}$. These results correspond to a variation of temperature and electron density gradient between the minimum and maximum of the solar cycle. Comparison of these results with temperatures and densities deduced from optical data shows that there is good agreement when solar activity is taken into account. (auth)

39202 EXCITATION CROSS SECTIONS IN Fe XIV. Petrini, D. (Observatoire, Nice). Astron. Astrophys., 1: 139-41(Feb. 1969).

Using the close-coupling method, cross sections of Fe XIV are computed and compared to the Coulomb Born I approximation results. Provided that the configuration interaction is taken into account, the Coulomb Born results are very satisfactory. (auth)

39203 WHAT NEXT WITH SOLAR NEUTRINOS? Bahcall, John N. (California Inst. of Tech., Pasadena). Phys. Rev. Lett., 23: 251-4(Aug. 4, 1969).

The capture rate of solar neutrinos is estimated for a number of targets that have been suggested previously as possible detectors of solar neutrinos. It is shown that the most important feasible experiment to be carried out in the future employs ^{7}Li as a detector. (auth)

39204 INSTRUMENTAL PROFILE OF THE UTRECHT SOLAR ATLAS. Griffin, R. F. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 143: 361-79(1969).

The method of oxygen-band convolutions shows that the second-order instrumental profile of the spectrograph used for the Atlas was much narrower than the authors of the Atlas supposed, having a half-width of about 40 mÅ at λ6000 Å instead of 61 mÅ. The error was largely in assuming that the observed half-widths of absorption lines result from quadratic addition of the intrinsic and instrumental half-widths. The failure of this assumption has important bearings on other astronomical measurements. Some effects of the newly derived instrumental profile upon absorption lines are calculated, and the asymmetry seen in absorption lines in the Utrecht Atlas is faithfully reproduced. For reasons associated with the instrumental profile, the equivalent widths of moderately strong lines will be undermeasured by 2 to 10% or more, depending upon the local complexity of the spectrum, while weak lines will be under-measured by about 15%. Stellar chemical abundances derived ultimately from the use of Utrecht Atlas equivalent widths may correspondingly be too large by 15%. An instrumental profile is deduced for the first-order spectra which constitute more than a third of the Atlas; although the resolving power is conspicuously poorer than in the second order, the quantitative effects of the first-order profile upon the observed spectrum are less damaging than those of the second order as regards central intensities and equivalent widths. (auth) (UK)

39205 INSTRUMENTAL PROFILE OF THE LIEGE SOLAR ATLAS. Griffin, R. F. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 143: 349-59(1969).

The instrumental profile given by the authors of the Liège Atlas was refined by a trial-and-error procedure, in which the instrumental profile was convoluted with the profile of the telluric A band observed at very high resolution with the McMath spectrometer at Kitt Peak. A good approximation to the effective instrumental profile at λ7600 Å resulted from convoluting the profile (scaled according to wavelength) quoted by the authors with a Gaussian function of half-width 30 mÅ, and had a half-width of 63 mÅ. Some effects of the instrumental profile are discussed. (auth) (UK)

39206 CORRELATION BETWEEN CORONAL ENHANCEMENTS OBSERVED AT 5303 A AND 6374 A AND RADIO CONDENSATIONS AT A FREQUENCY OF 169 MHz. Leblanc, Y. (Observatoire, Meudon, France). Astron. Astrophys., 1: 467-72(Apr. 1969).

A daily comparison between the 5303-Å line emission and the S component at a frequency of 169 MHz is made: when a radio center is observed on one limb, the apparent size of the corona increases and enhancement of the green line emission is observed on this limb. Similarly the variation of the coronal equatorial diameter and the mean intensity of the green line emission are well correlated during the entire solar cycle. It is found that the total flux density of the corona reached a minimum in 1963. During the same year the mean red line emission was a maximum. If it is assumed that the flux density represents a mean temperature of the whole corona, it is concluded that the coronal temperature was a minimum in 1963. (auth)

39207 PARTIAL PHYSICAL EXPLANATION OF THE RELATIONS BETWEEN SOLAR ACTIVITY AND CM EMISSIONS. Lantos, P. (Observatoire, Meudon, France). Astron. Astrophys., 1: 492-3(Apr. 1969).

The sensitivity of the 3 cm-flux density to physical conditions in the solar atmosphere is shown to be a consequence of the existence of a maximum (different from the 10-cm one) in the flux density spectrum F_λ of active regions. This second maximum of F_λ can be explained without assuming a maximum in the variation of the brightness temperature T_b with λ. (auth)

39208 ON SOME CHARACTERISTIC FEATURES OF TYPE IV BURSTS. PART III. ELECTRON ACCELERATION IN A COLLISIONLESS SHOCK WAVE IN THE SOLAR CORONA. Lacombe, C.; Mangeney, A. (Observatoire, Meudon, France). Astron. Astrophys., 1: 325-33(Mar. 1969).

On September 14, 1966 a radio solar event was observed by Boischot and Clavelier on the west limb of the Sun. It was a moving type-IV burst, which emitted synchrotron radiation and maintained a constant source size; it appeared in the corona at a height of 1 $R_\odot$ above the photosphere, and moved with a constant speed of 530 km/s up to 1.7 $R_\odot$ where it spread and disappeared. With the values of the electron density, temperature, and magnetic field generally used in the corona, it was found that the source appeared and disappeared for critical values of the Alfvén Mach number corresponding to the values for collisionless shock waves given by the theory of Sagdeev and Galeev. The observations of such an event seem to prove that electrons can be accelerated in the shock wave high in the corona: using theoretical works by Kadomtsev and by Tsytovich it is shown that a statistical acceleration is possible if it is supposed that a stationary energy spectrum of turbulent ion acoustic waves, isotropic in wave vector space, is excited in the shock front. (auth)

39209 IONIZATION OF HIGHLY CHARGED POSITIVE IONS. Bely, C.; Schwartz, S. B. (Observatoire, Nice). Astron. Astrophys., 1: 281-5(Mar. 1969).

Theoretical results are given for the ionization of highly ionized ions having one or two open shells before the collision. Approximate sum and selection rules are obtained. Results are presented for the ionization of Fe XIV by electron impact. The corresponding rates are given for temperatures up to 4×10^6 °K. (auth)

39210 PHOTOGRAPHY OF THE UV LINES IN THE SOLAR CORONA. Rozelot, J. P. (Observatoire du Pic-du-Midi, Bagneres de Bigore, France). Astron. Astrophys., 2: 122-5(May 1969). (In French).

The following results were obtained from a spectroscopic analysis of the coronal line $^1D_2 - {}^3P_2$ of Fe XIII: the accurate wavelength of this line is 3388.16 Å, the radial gradient is 0.20, the half-width is 0.48 Å, and the kinetic temperature $2.18\ 10^6$ °K. A new uv coronograph put into operation at the Pic-du-Midi Observatory has made it possible to get this line photographically and a brief description of the apparatus is given. By a simple change of optical systems, the λ 5303 Å and γ 6374 Å lines can also be photographed; thus a homogeneous set of the three states of ionization (X, XIII and XIV) of coronal iron is obtained. (auth)

39211 FORBIDDEN LINES OF Fe II IN THE SOLAR PHOTOSPHERIC SPECTRUM. Grevesse, N.; Swings, J. P. (Institut d'Astrophysique, Liege). Astron. Astrophys., 2: 28-44(May 1969).

The theoretical profiles and equivalent widths of Fe II lines in the solar photospheric spectrum are predicted. They are compared to the values observed on new direct intensity tracings obtained at the International Scientific Station, Jungfraujoch. Twenty faint solar absorption lines may be assigned to Fe II; each of them is studied in detail. The photospheric iron abundance deduced from this investigation is $\log N_{Fe} = 7.50$ (in the scale $\log N_H = 12.00$) in agreement with the coronal and meteoritic values. The possible presence of Fe I lines is also discussed. Two observed solar features at λ 5303.99 and λ 5220.57 Å may be due to Fe I; their transition probabilities are estimated on the assumption that the identifications are correct. A discussion of the discrepancies between the solar and theoretical wavelengths of the Fe II lines is given. (auth)

39212 ON THE INTERPRETATION OF THE CENTER-LIMB OBSERVATIONS OF Ca II EMISSION CORES. Dumont, S. (Observatoire, Meudon, France). Astron. Astrophys., 2: 45-51(May 1969).

Zirker's interpretation of his center-limb observations of the emission cores of Ca II are discussed. It is shown that, in an atmosphere with constant Doppler width, Zirker's method leads to a good result if the chromosphere is "thin." But if it is "thick," the method will yield a Doppler width which is somewhat too large. When an atmosphere where the Doppler width increases rapidly with height is considered, Zirker's method gives a "mean" Doppler width which does not correspond at all to the region where the emission peaks are created but which, on the contrary, corresponds to a very superficial region. In consequence, a "thick" chromospheric model with a Doppler width which increases rapidly with height is consistent with the center-limb observations of the emission lines of Ca II. (auth)

39213 ABUNDANCE DETERMINATION IN THE SOLAR CHROMOSPHERE. Pecker, J. C.; Pottasch, S. R. (Observatoire, Nice. Kapteyn Astronomical Lab., Groningen, Netherlands). Astron. Astrophys., 2: 81-95(May 1969).

It is shown that abundances of the metals can be obtained from observations of the solar chromosphere; departures from local thermodynamic equilibrium are taken into account. Results are given for iron, titanium, scandium, strontium, and barium. (auth)

39214 CURRENT LIMITATION AND SOLAR FLARES. Carlqvist, P. (Royal Inst. of Tech., Stockholm). Solar Phys., 7: 377-92(June 1969).

A flare model based on force-free currents in the solar atmosphere is considered. The energy of the flare is supposed to be stored as magnetic energy in the current system. If the current density exceeds a certain critical limit an over-voltage may arise in the circuit which will give rise to a rapid release of the stored energy. At the end of the paper, some results yielded by the model are compared with observational evidence of flares. (auth)

39215 THE OBSERVATION OF SOLAR SOFT X-RAY BURSTS AND THEIR RELATIONS TO MICROWAVE RADIO BURSTS. Chambe, G.; Sain, M. (Observatoire, Meudon, France). Astron. Astrophys., 2: 133-42(June 1969). (In French).

Twenty-five solar soft x-ray bursts in the 0.5 to 3, 1 to 8, and 8 to 16 Å wavelength ranges were studied, using data obtained by the satellite Solrad 8. Two separate classes of bursts were found. Impulsive bursts: both the increasing phase and the early decreasing period are short (≈ 2 minutes). The 0.5 to 3 A flux reaches its maximum about one minute before the 8 to 16 A flux. These bursts are closely correlated with the impulsive microwave radio bursts which, however, occur during the increasing phase of the soft x-ray events only. An interpretation of these facts is given supposing that the emitting region reaches its higher "temperature" when the acceleration of the electrons responsible for the radio burst comes to an end, and then expands while cooling down. "Gradual rises and falls": the soft x-ray spectrum exhibits only a slight hardening during the flux enhancement. The correlation with microwave "gradual rises and falls" is good. The heating of a confined plasma accounts for these phenomenons. The bursts that cannot fit into one of these categories generally occur beyond 80° (heliocentric) of the disk center. Therefore, limb effect seems to be present especially for radio emission, which seldom shows a counterpart to these types of x-ray events, implying a big absorption or anisotropy of the microwave radiation. (auth)

39216 THE TREATMENT OF RESONANCE SCATTERING OF POLARIZED RADIATION IN WEAK MAGNETIC FIELDS BY THE MONTE CARLO TECHNIQUE. House, Lewis L.; Cohen, Leonard C. Astrophys. J., 157: 261-74(July 1969).

The problem of resonance scattering in a finite medium which is permeated by a uniform magnetic field is described. A parallel beam of unpolarized photons is assumed incident upon the lower surface of the scattering medium, the direction of propagation being perpendicular to the magnetic field. Through inclusion of the Hanle effect which influences the phase coherency of the scattering process, it has been possible to treat the case of weak fields for the normal Zeeman triplet. This is in contrast to most studies of the transport of polarized radiation in which a strong field is assumed, giving rise to well-separated Zeeman components. By the Monte Carlo process "photons" are traced through the scattering medium by using the probabilistic laws of interaction, and, by counting the "photons" as they exit, line profiles and the degree of polarization are determined. Results are given for viewing the medium both along and perpendicular to the magnetic field. When the medium is

optically thin and viewed along the magnetic field, the linear polarization may change from 100 to 0% because of the Hanle effect. As the optical depth increases, additional depolarization occurs because of multiple scattering, and it is found that an average of only five to ten scatterings are required to completely depolarize the radiation essentially independent of the magnetic field strength. Future application of this type of calculation is discussed in relation to quiescent prominences in the solar atmosphere. (auth)

39217 REVERSALS OF SELECTED Ce II SOLAR LINES. Canfield, Richard C. (High Altitude Observatory, Boulder, Colo.). Astrophys. J., 157: 425-37(July 1969).

Observations of six Ce II lines in the solar spectrum show that the lines reverse from absorption to emission on the disk, inside the limb. Furthermore, the position of this reversal varies with wavelength. Analysis implies that this behavior is due to the dominance of the scattering term in the line source function. The absorption-line profiles favor a nonthermal velocity field that is anisotropic. The emission-line profiles require a horizontal nonthermal velocity of 2.0 ± 0.2 km sec^{-1}, averaged over heights $0 < h < 400$ km. The equivalent widths and central intensities of the absorption lines require a cerium abundance $\log N_{Ce} = 1.4 \pm 0.3$ ($\log N_H = 12.0$), and favor the Bilderberg temperature distribution over that of Holweger. (auth)

39218 ROCKET OBSERVATIONS OF PROFILES OF SOLAR ULTRAVIOLET EMISSION LINES. Bruner, E. C. Jr.; Rense, W. A. (Univ. of Colorado, Boulder). Astrophys. J., 157: 417-24(July 1969).

High-resolution rocket spectra were photographed of solar hydrogen Ly a, Si III at 1206.52 Å, and O I at 1302 to 1306 Å; the profiles were corrected for instrumental broadening. The hydrogen Ly a profile can be accounted for by a non-LTE theory except in the wings. There is some evidence of solar self-reversal in the O I triplet, but none in the Si III line. Effects of plage areas are present for all lines. (auth)

39219 THE HARD SOLAR X-RAY SPECTRUM OBSERVED FROM THE THIRD ORBITING SOLAR OBSERVATORY. Hudson, Hugh S.; Peterson, Laurence E.; Schwartz, Daniel A. (Univ. of California, San Diego). Astrophys. J., 157: 389-415(July 1969).

The hard solar x-ray scintillation-counter telescope on the OSO-III satellite covers the energy range 7.7 to 210 keV with 15-sec time resolution, and six logarithmically spaced energy channels. Approximately 55% time coverage has been obtained for the period following the date of launching, March 8, 1967, until failure of the on-board tape recorder June 28, 1968. This paper is based mainly on solar x-ray events observed during the first two weeks of data accumulation. Approximately ten bursts per day were detected during the interval March 9-23, 1967, above the threshold sensitivity of 10^{-3} erg $(cm^2\ sec)^{-1}$ for $7.7 \leq h\nu \leq 12.5$ keV. About once per day a burst of peak energy flux greater than 1.6×10^{-5} erg $(cm^2\ sec)^{-1}$ was observed. Although many variations were observed, the typical event had an e-folding rise time of 86 sec and a decay time of 458 sec. The bursts occurred in correlation with almost all listed flares and subflares (88%), microwave bursts (92%), and SID's (100%). Numerous bursts were also detected without these accompanying phenomena. The correlation with type III radio bursts, although still positive, is not as good (31%), a fact which suggests that coronal disturbances are not an inevitable consequence of the process which produces x-ray emission. The x-ray spectrum is appreciably nonthermal in the initial phase of the burst and thermal in the decay phase, with an effective temperature often exceeding 50×10^6 K. The average peak temperature of subflares exceeds 10×10^6 K, while that of importance 1 or greater exceeds 14×10^6 K. The emission measure $n_e n_i V$ has a constant value of about 1.4×10^{47} cm^{-3} both during an x-ray burst and from burst to burst. The solar x-ray bursts therefore differ mainly in the maximum temperature attained. A less detailed examination of later data shows that the phenomena described are not peculiar characteristics of a single active region. (auth)

39220 THE γ'-SYSTEM OF THE TiO MOLECULE. Phillips, John G. (Univ. of California, Berkeley). Astrophys. J., 157: 449-58(July 1969).

A rotational analysis of the (0,0) band of the γ'-system of the TiO molecule shows that the system is produced by a transition from a $^3\Pi$ state to the ground state ($X\ ^3\Delta$) of the molecule. Transitions producing the a- and γ-systems are thus changed to $^3C\ \Delta - X\ ^3\Delta$ and $A\ ^3\Phi - X\ ^3\Delta$, respectively. Suggestions are made regarding other bands belonging to the γ'-system. (auth)

39221 COMPARISON OF ENERGETIC STORM PROTONS TO HALO PROTONS. Kahler, S. W. (Univ. of California, Berkeley). Solar Phys., 8: 166-85(July 1969).

Satellite observations of solar proton events with a "halo" structure or an energetic storm proton event and an SSC are studied. It is pointed out that some SSC events are associated with a decrease in the few-MeV cosmic-ray fluxes while most are associated with a flux increase. The properties of halo protons and energetic storm protons are compared. It is hypothesized that the two events are similar in origin. The propagation mode of storm particles is discussed. Evidence is presented for a solar, rather than interplanetary origin of storm protons. (auth)

39222 SOLAR PROTONS E > 100 MeV INCIDENT OVER ANTARCTICA DURING JANUARY-FEBRUARY 1967. Barcus, J. R. (Univ. of Denver). Solar Phys., 8: 186-203(July 1969).

Commencing at 0825$\pm\frac{1}{2}$ UT on January 28, 1967, a large and prolonged increase in the intensity of penetrating charged particles was observed by balloon-borne instruments floating over Byrd Station, Antarctica (80°S, 120°W). A peak intensity of approximately 60 protons per cm^2-sec-steradian with E > 100 MeV occurred at about 1230 UT on the 28th. The event was under observation almost continuously over a period of about 100 hours until the intensity decayed below cosmic-ray background on February 1. The initial decay was rapid but, some 40 hours after onset, went over into a slow exponential decay characterized by a 20-hour time constant. The decay phase of an additional, though considerably less intense, event was observed on February 3 and 4. Presumably, both events had their origins in major disturbances on the far side of the Sun since neither event has been definitely linked to any feature which existed on the visible disk within an appropriate time interval. Results pertaining to the time-intensity profile and to the energy spectrum for protons E > 100 MeV are presented for the January 28 event. Comparison of the balloon results with neutron-monitor and satellite measurements and with models of interplanetary diffusion has led to some conclusions regarding the role of small-angle scattering by irregularities and by the random walk of magnetic lines of force relative to the mean interplanetary field within the orbit of Earth. (auth)

39223 SOME FEATURES OF THE SOLAR MICROWAVE EMISSION AND THEIR CONNECTION WITH GEOMAGNETIC ACTIVITY. II. STATISTICAL PROPERTIES OF THE MICROWAVE EMISSION ASSOCIATED WITH SUNSPOTS. Roosen, J. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Solar Phys., 8: 204-25(July 1969).

A statistical investigation of the slowly varying component of the 9.1-cm solar radio emission is based upon the Stanford radioheliograms covering the years 1962-66. On the average, the peak value of the brightness temperature T_b is proportional to the area covered by the corresponding spot group. However, in individual cases, the observed T_b is definitely lower or higher than is to be expected from the size of the spot group. The concept "microwave importance" I_m of the spot group is introduced, which is the T_b to be expected from the Zürich class and spot number; and the concept "relative brightness" B_r, which is the ratio of the observed T_b to I_m. This leads to the distinction of "faint", "normal" and "bright" sources with $B_r \leq 0.8$, $0.8 < B_r < 1.2$, and $B_r \geq 1.2$, respectively. B_r is correlated with the maximum magnetic-field strength H observed in the spot group and with the flux-density spectrum of the source. The yearly average of B_r and the average flux-density spectrum vary with the phase of the solar cycle. An analysis of the results is based upon the electron-density distribution in the condensation, which was visible at the solar limb during the eclipse of February 5, 1962, and on an adopted temperature distribution with a central value of 4×10^6 K. The computed T_b, including gyro-resonance absorption, agrees with the value derived from the microwave importance of the spot group and $B_r = 0.5$, which shows that in the current gyro-resonance models the electron density is underestimated. The variation of T_b with the size of the spot group can be explained by varying the dimensions of the condensation in area and in height, if the central density and temperature remain constant. The statistical relationships between B_r and H and between B_r and the flux-density spectrum yield a model for the differences between faint and bright sources: B_r increases with the contribution from the gyro-resonance absorption and with the central electron density. (auth)

39224 ENHANCEMENT OF IONIZING RADIATION DURING A SOLAR FLARE. Garriott, O. K. (Stanford Univ., Calif.); Da Rosa, A. V.; Davis, M. J.; Wagner, L. S.; Thome, G. D. Solar Phys., 8: 226-39(July 1969).

Measurements of electron concentrations in the ionosphere, between 100 and 250 km, were used to compute the increase in solar ionizing radiation during two flares on May 21 and 23, 1967. Since the altitude of maximum absorption of the solar energy (approximately unit optical depth) depends on the wavelength of the radiation, it is possible to estimate separately the energy enhancement in different portions of the spectrum. An ionizing

energy flux increase of nearly 5 erg cm^{-2} sec^{-1} was observed on May 21, while on the 23rd the increase was over 7 erg cm^{-2} sec^{-1}. In both flares, most of the absolute increase occurred in the 20 to 205-Å region of the spectrum, although the relative increase was much larger at the shorter wavelengths. (auth)

39225 POWER SPECTRA OF THE INTERPLANETARY MAGNETIC FIELD. Sari, James W. (Univ. of Maryland, College Park); Ness, Norman F. Solar Phys., 8: 155-65(July 1969).

Power spectra based on Pioneer 6 interplanetary magnetic field data in early 1966 exhibit a frequency dependence of f^{-2} in the range 2.8×10^{-4} to 1.6×10^{-2} cps for periods of both quiet and disturbed field conditions. Both the shape and power levels of these spectra are found to be due to the presence of directional discontinuities in the microstructure (<0.01 AU) of the interplanetary magnetic field. Power spectra at lower frequencies, in the range of 2.3×10^{-6} to 1.4×10^{-4} cps, reflect the field macrostructure (>0.1 AU) and exhibit a frequency dependence roughly between f^{-1} and $f^{-\frac{1}{2}}$. The results are related to theories of galactic cosmic-ray modulation and are found to be consistent with recent observations of the modulation. (auth)

39226 ABUNDANCES OF THE RARE EARTHS IN THE SUN. Grevesse, N.; Blanquet, G. (Institut d'Astrophysique, Cointe-Sclessin, Belg.). Solar Phys., 8: 5-17(July 1969).

Solar abundances of the rare earths (La, Ce, Pr, Nd, Sm, Eu, Gd, Dy, Er, Tm, Yb, Lu) were determined on the basis of measurements made on new high-resolution tracings of the solar spectrum obtained at the International Scientific Station of the Jungfraujoch (Switzerland) by L. Delbouille, L. Neven, and G. Roland. Results are compared with those of other authors for the Sun and meteorites, as well as with the abundances predicted by nucleosynthesis theories. (auth)

39227 FREQUENCY DEPENDENCE OF THE LINE SOURCE FUNCTION. Worrall, Gordon (Cambridge Univ., Eng.). Solar Phys., 8: 18-19(July 1969).

This note points out that the assumption of frequency independence for a line source function in the solar atmosphere has the consequence that the spectral line disappears at the limb of the Sun. It is further pointed out that, although inhomogeneities make it impossible to observe the limb in the geometrically required sense, the substantial strength of many absorption lines close to the limb dictates that they are not formed by pure absorption, therefore the relevant line source functions are frequency-dependent. The brief theoretical treatment in this note also indicates frequency dependency. (TSS)

39228 GRANULATION MODELS. Wilson, P. R. (Univ. of Sydney). Solar Phys., 8: 20-2(July 1969).

Recently Margrave and Swibart (Solar Phys., 6: 12(1969)) proposed a two-column model for photospheric granulation. The author, in this note, gives arguments to show that the above model is wrong, not just in detail, but in its overall qualitative description of the granulation region. (TSS)

39229 INTENSITY OF THE PENUMBRA OF LARGE SUNSPOTS. Maltby, P.; Mykland, N. (Univ. of Oslo). Solar Phys., 8: 23-8(July 1969).

Simultaneous photoelectric observations of sunspot penumbrae at 5,790, 6,690, 8,760 and 16,700 Å are presented. No change in penumbral intensity from spot to spot is found in a sample of 11 large sunspots. (auth)

39230 MOTIONS IN ARCH FILAMENT SYSTEMS. Bruzek, A. (Fraunhofer Institut, Freiburg i. B.). Solar Phys., 8: 29-36 (July 1969).

A new analysis of Hα filtergrams and Hα spectra of arch filament systems (AFS) shows that material flows downwards in both branches of the arch filaments ($v \approx 50$ km/sec) while the top of the arches ascends ($v \lesssim 10$ km/sec). It is suggested that AFS are produced by the magnetic field which expands, between growing spots, into higher levels carrying material with it that subsequently slides down along the magnetic field following gravity. AFS are also visible in the K line of Ca II; however, there they appear less pronounced than in Hα and they are less conspicuous than the K-line quiescent filaments. There is some indication that AFS just cover a supergranulum (Ca network cell) with material streaming down at the border of the cell. No indication was found for a close relationship between AFS and flares. (auth)

39231 STABILITY ANALYSIS OF THE KIPPENHAHN–SCHLUETER MODEL OF SOLAR FILAMENTS. Anzer, U. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys., 8: 37-52(July 1969).

The stability of the Kippenhahn–Schlüter model of solar filaments against arbitrary perturbations is investigated. The problem is treated in the MHD approximation and a modification of the energy principle of Bernstein et al. is used. Two necessary and sufficient stability conditions are found: (a) $[B_z]\, dB_x/dz \geqq 0$ and (b) $B_x\, d[B_z]/dz \leqq 0$. Condition (a), in the limit of small currents, leads to the condition already discussed by Kippenhahn and Schlüter; condition (b) requires that the current density in the stable filament decreases with height. (auth)

39232 SOLAR PHOTOGRAPHY IN THE EXTREME ULTRAVIOLET. Burton, W. M. (Astrophysics Research Unit, Abingdon, Eng.). Solar Phys., 8: 53-71(July 1969).

Pinhole-camera instrumentation was carried on stabilized Skylark rockets to record images of the Sun at euv wavelengths. This paper describes the equipment used and the results obtained during five rocket flights between August 1964 and February 1966. The spectral sensitivity of the various cameras and the effects of atmospheric absorption are estimated in order to determine the effective wavebands which form the solar images. The euv images are compared with observations of the Sun made at visible wavelengths. (auth)

39233 SYSTEMATIC PHOTOMETRY OF XUV SOLAR IMAGES. Allen, C. W. (London Univ.). Solar Phys., 8: 72-87 (July 1969).

Units and methods have been devised to express the photometry of solar xuv images. The source and limb-brightened fluxes are given in terms of the Sun's quiet central intensity. Measurements made on this system can be meaningfully compared with solar data and with theoretical predictions. Calculations have been made of the xuv distribution for optically thin solar models and results have been converted onto the measurement system. Photometric measurements have been made from four films lent by the Culham and Leicester Laboratories. Certain inconsistencies suggest that the measurement accuracy is not yet good enough for definitive results. However, there is evidence that: (a) the x-ray emission sources are brighter, relative to the quiet Sun, than the longer-wave euv sources; (b) x-ray limb photons all escape (i.e., limb optically thin) but euv limb emission is affected by absorption; and (c) the observed image diameter fits an emission scale height of $0.05\, \mathcal{R}_\odot$. (auth)

39234 IMPROVEMENT OF CORONAL EMISSION LINE PHOTOGRAPHS. Pope, Thomas (Univ. of Hawaii, Honolulu). Solar Phys., 8: 88-90(July 1969).

In planetary photography with small- to medium-aperture telescopes the faintness of the sources requires the use of fast but grainy film for reasonably short exposures. The unfavorable signal-to-noise ratio attained for a single exposure can be improved by the photographic addition of two or more images. The improvement in image quality results from a reduction in graininess, and from the lower weight given to anomalous emission effects, as the number of images in the composite is increased; graininess is reduced proportionally to the square root of the number of images. This note illustrates the application of such a composite technique to monochromatic photographs of the solar corona, and suggests its use in extracting the maximum amount of information from the data. (TSS)

39235 Fe XII IN CORONAL EMISSION. Rozelot, J.-P. (Observatoire du Pic-du-Midi, Bagneres-de-Bigorre, France). Solar Phys., 8: 91-103(July 1969). (In French).

Assuming that Fe XII is reduced to 16 energy levels, the relative intensities of 21 spectral lines as a function of two parameters, temperature and electron density, were computed. Results are briefly discussed and summarized. (auth)

39236 PLASMA TURBULENCE IN SOLAR FLARES AS AN EXPLANATION OF SOME OBSERVED PHENOMENA. Friedman, M.; Hamberger, S. M. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Solar Phys., 8: 104-14(July 1969).

It is suggested that, in Petschek's model of magnetic field annihilation, plasma which flows through the boundary layer where its magnetic energy is released is rendered highly turbulent by current-driven electrostatic instability. This leads to a physical insight into the mechanism of dissipation, and, by analogy with laboratory experiments on turbulent plasma, can explain the observed x-ray and microwave emissions. When the microstructure is calculated using electric conductivity appropriate to highly turbulent plasma, a field configuration exists in which protons can be accelerated to very high energies. The results of some numerical calculations of this process are presented. (auth)

39237 MECHANISM FOR THE BUILD-UP OF FLARE ENERGY. Stenflo, Jan Olof (Astronomical Observatory, Lund, Sweden). Solar Phys., 8: 115-18(July 1969).

It is shown how the kinetic energy of the rotational motion of a sunspot can be transferred to electromagnetic energy in filamen-

tary currents. The time needed for preconditioning the solar atmosphere for a flare varies within wide limits. For small flares it may be of the order of minutes; for large flares, of the order of hours or days. (auth)

39238 MICROWAVE AND HARD X-RAY BURSTS FROM SOLAR FLARES. Holt, Stephen S.; Ramaty, Reuven (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys., 8: 119-41(July 1969).

Detailed theories were applied of gyro-synchrotron emission and absorption in a magnetoactive plasma, x-ray production by the bremsstrahlung of nonthermal electrons on ambient hydrogen, and electron relaxation in a partially ionized and magnetized gas to the solar-flare-burst phenomenon. The hard x-ray and microwave bursts are shown to be consistent with a single source of nonthermal electrons, where both emissions arise from electrons with energies $<mc^2$. Furthermore, the experimental x-ray and microwave data allow deduction of the properties of the electron distribution and values of the ambient magnetic field, the hydrogen density, and the size of the emitting region. The proposed model, although derived mostly from observations of the July 7, 1966 flare, is shown to be representative of this type of event. (auth)

39239 LONGITUDINAL DISTRIBUTION OF X-BREMSSTRAHLUNG ON THE SOLAR DISC. Pinter, Stefan (Geophysical Inst., Hurbanovo, Czech.). Solar Phys., 8: 142-8 (July 1969).

The dependence of the intensity of solar bremsstrahlung in the spectral range from 1 to 60 keV on heliographic longitude is investigated. Considering a flare mechanism, which assumes that the electrons move in a preferred direction in the course of their acceleration (according to the model of Takakura and Kai (1966) the electrons move parallel to the solar surface), it is concluded that the maximum of the bremsstrahlung intensity is shifted with increasing electron velocity towards the direction of motion of electron beams. In the case of the Takakura and Kai flare mechanism, the slow electrons ($\beta = 1/10 - 1/20$), i.e., with small energies of 1 to 10 keV, reach the maximum of the bremsstrahlung intensity round the CM; for higher velocities ($\beta \approx 1/3 - 1/4$), i.e., for higher energies of 10 to 60 keV, the direction of the maximum is shifted away from the CM towards the disc limb. These theoretical conclusions were proved by experimental research conducted by means of satellites. (auth)

39240 HOMOLOGY OF X-RAY BURSTS. Pinter, S. (Geophysical Inst., Hurbanovo, Czech.). Solar Phys., 8: 149-51 (July 1969).

It is demonstrated on the basis of two series of events that one can extend the homology so far known for optical and radio flares to the hard and soft x-ray bursts. The studied homologous x-ray flares occurred in the same active region and their time–intensity profiles were very similar. It has been found that the detected homologous x-ray bursts are associated with radio bursts that also are homologous. The time profile of centimeter radio bursts frequently is repeated in detail when compared with the time profile of x-ray bursts. This very close correspondence suggests that the centimeter radio bursts and x-ray bursts are generated simultaneously during flares, probably in the same region (Sengupta, 1968). Arnoldy et al., (1968) have found a detailed correlation between the time–intensity profiles of hard x-ray bursts and 3- or 10-cm radio bursts. This close correlation between the hard x-ray bursts and centimeter radio bursts leads to a suggestion that the hard x-ray and centimeter radio bursts are generated by the same electrons. On the basis of these considerations one can more easily understand the homology of both the x-ray bursts and the radio bursts. The occurrence of homologous bursts then can be explained by an existence of regions on the Sun in which for a certain time (48 hr after Fokker) the same conditions are maintained in the acceleration of the electrons generating the x-ray and radio bursts. (auth)

39241 SOLNECHNYE KOSMICHESKIE LUCHI. (Solar Cosmic Rays). Dorman, L. I.; Miroshnichenko, L. I. Moscow, Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury, 1968. 468p.

Data collected on solar cosmic radiation during 1947 to 1967 period are reviewed. Problems on generation and propagation of solar cosmic rays, especially, the aspects of solar particle energy spectra (power and exponential function of the hardness of rays) and coefficients of diffusion as functions of particle energy and distance from the Sun are analyzed. Geophysical effects of cosmic rays, energy spectra, nuclear composition and time variations of solar cosmic rays are discussed. Propagation of cosmic rays in interplanetary space, solar flares, chromospheric bursts, Forbush effects, and geomagnetic storms are studied and theoretical interpretations are given for various problems on physics of solar bursts and solar particle composition and mechanisms of solar particle injection and acceleration. 682 references. (R.V.J.)

39242 SOME RELATIONS BETWEEN 3-cm SOLAR RADIO BURSTS, FLARES, X RAYS, AND GEOMAGNETIC CROCHETS. Pinter, S. (Geophysical Inst., Hurbanovo, Czech.). Bull. Astron. Inst. Czech., 20: 151-6(1969).

The time relations of soft and hard X radiation, centimeter radio bursts, and expansive and Y phases of flares with geomagnetic crochets were investigated. It is shown that not all flares are equally geoactive, their wave geoactivity depending on the height of the incept of their expansion in the solar atmosphere. These correlations give rough data on the ionizing radiation which results in crochets. (auth)

39243 FLARES WITH THE EJECTION OF SUBCOSMIC RADIATION IN THE REGION OF N 27°, CMP MAY 25, 1967. Krivsky, L. (Astronomical Inst., Ondrejov, Czech.); Pinter, S. Bull. Astron. Inst. Czech., 20: 147-51(1969).

Data are summarized concerning four flares with the ejection of subcosmic radiation in the proton-active region. The situation according to which the forecast of proton flares in this region was announced is described. There is a full description of the development of the flare of May 28, 1967, and of some effects caused by the flare x emission, such as a crochet and geomagnetic pulsations. The computation of the multiple of the recombination coefficient and the electron concentration in the D region as deduced from the flare and crochet evolution is given. (auth)

39244 COMPENSATION OF THE MAXIMUM MAGNETIC FIELD STRENGTHS OF OPPOSITE POLARITIES IN GROUPS OF SPOTS AT THE TIME OF PROTON FLARES. Krivsky, L.; Ruzickova-Topolova, B. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 20: 145-6(1969).

It is clear from statistical treatment that there exists a tendency for proton flares to occur in a proton group of spots at a time when the maximum values of the field strength in the spots of opposite polarities are approximately compensated. It is possible that this tendency is really a consequence of the occurrence of a situation of approximate equilibrium of the magnetic fluxes of both polarities in the spot group at the time when the proton flare originates. This hypothesis is, it seems, in harmony with one published by the author elsewhere. (auth)

39245 DEVELOPMENT AND SPATIAL STRUCTURE OF PROTON FLARES NEAR THE LIMB AND CORONAL PHENOMENA. I. FLARE ON 5.IV.1960. Krivsky, L. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 20: 139-44 (1969).

On the basis of photographs of the ascending-tube type of proton flare of Apr. 5, 1960, the velocity of the top ascending emission filament, located at the tops of the widening flare loop channel in H_α and in a number of coronal lines, was investigated at the time the filament was moving over onto the solar disc. The identity of this emission filament was determined at the time of projection into the disc with a coronal filament in a latter period, when the filament continued in its ascension above the limb of the solar disc. Extrapolation was employed to determine the interval in which a rapid widening of the flare tube occurred at the beginning of the rapid development of the flare (Y phase). The results presented in this part of the paper also served for the preliminary publication on the generation of proton flares due to the ascension of a magnetic channel into a directionally opposing magnetic structure in a spot group (Křivský, 1968). (auth)

39246 NEUTRINOS FROM THE SUN. Bahcall, John N. Sci. Amer., 221: 29-37(July 1969).

The thermonuclear reactions in the Sun giving rise to neutrino emission are discussed. The Davis experiment at Lead, S. D. is described, and it is mentioned that the initial results have left astrophysicists somewhat puzzled because the neutrino flux rate seems low. It is less than half the theoretical value one obtains by assuming certain "standard" values for quantities used in constructing theoretical models of the solar interior. The range of the theoretical predictions is discussed. (W.D.M.)

39247 BIRTH OF ACTIVE REGIONS. Weart, Spencer R.; Zirin, Harold (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac., 81: 270-3(June 1969).

Small regions, very bright in Hα, with parallel dark loops, are discussed. These regions often precede the growth of large sunspot groups. The loops nearly always rotate spasmodically towards east–west during the course of a day. (auth)

Galaxies

39248 (D-1-82-875) SOME DIFFRACTION TECHNIQUES FOR X-RAY ASTRONOMY. Lytle, Farrel W.; Bingham, R.

Graham (Boeing Scientific Research Labs., Seattle, Wash. Solid State Physics Lab.). July 1969. 51p.

Theories of x-ray diffraction applicable to x-ray astronomy techniques are developed. The preparation of crystals for maximum diffracted intensity is discussed and experimental measurements for LiF and graphite are given. The role of the "integrated reflection coefficient" in maximizing and calculating the effective gain of astronomical instruments is discussed. Two instruments, "The Confocal Paraboloid X-ray Lens" and "The Asymmetric Bragg Cosmic X-ray Polarimeter" are presented as examples and their performance estimated. A flight model of the Lens and a laboratory model of the Polarimeter have been constructed; details are given. (auth)

39249 FURTHER MEASUREMENTS OF MAGNETIC FIELDS IN INTERSTELLAR CLOUDS OF NEUTRAL HYDROGEN. Verschuur, G. L. (National Radio Astronomy Observatory, Green Bank, W. Va.). Nature (London), 223: 140-2(July 12, 1969).

A new series of measurements of the Zeeman splitting of 21-cm spectral lines revealed strong (>10^{-5} G) magnetic-field effects in several neutral hydrogen clouds in the direction of H II regions. Low limits were set to the line-of-sight field components in six other regions of space. (auth) (UK)

39250 OBSERVATIONS OF M82 IN THE OPTICAL INFRARED. Bertola, F. (Osservatorio Astrofisico, Asiago, Italy); D'Odorico, S.; Ford, W. K. Jr.; Rubin, V. C. Astrophys. J., 157: L27-8 (July 1969).

A sequence of direct photographs of M82 from the blue to 1 μ was obtained. There is a small nucleus which becomes more prominent at longer wavelength. Infrared spectra reveal unbroadened, inclined emission lines of [S III] and He I λ10830. (auth)

39251 NEW INFRARED OBSERVATIONS OF THE GALAXY M82. Raff, Malcolm I. (Univ. of California, Berkeley). Astrophys. J., 157: L29(July 1969).

New infrared plates of M82 show several sources of radiation around the optical center. Its recent classification as a late-type spiral is subject to doubt. (auth)

39252 1.65 TO 19.5-MICRON OBSERVATIONS OF THE GALACTIC CENTER. Becklin, E. E. (California Inst. of Tech., Pasadena); Neugebauer, G. Astrophys. J., 157: L31-6(July 1969).

New observations of the nucleus of the Galaxy in the wavelength region between 1.65 and 19.5 μ are presented. At 10 and 20 μ radiation originates in a source approximately 1 pc in diameter. The energy distribution of the galactic-center source is similar to that measured in the nuclei of Seyfert galaxies (Low and Kleinmann). Two possible mechanisms that could produce the infrared radiation are briefly discussed. (auth)

39253 PHOTOMETRY OF THE OUTER CORONA OF MESSIER 87. de Vaucouleurs, Gerard (Univ. of Texas, Austin). Astrophys. Lett., 4: 17-22(July 1969).

A faint outer corona surrounding the main body of M87, detected by repeated photoelectric scanning along the E-W and N-S directions, has been traced out to a minimum diameter in excess of one degree at a brightness level of 1% of the night sky, $\mu_B \simeq$ 27.3 mag sec^{-2}. The coronal brightness, corrected for the extrapolated spheroidal (r^4) luminosity law of the main body, follows an exponential distribution with effective radius $r_e^* = 15 \pm 2.5$ arc min. The integrated magnitude of the main body is $B_T \simeq 9.5 \pm 0.1$, that of the corona $B_T = 10.0 \pm 0.1$ for a total magnitude $B_T \simeq 9.0 \pm 0.1$. The color indices B-V, U-B decreasing outwards from 0.95, 0.55 near the center to 0.6, 0.1 in the corona, are consistent with a stellar population of mean metallicity index $Q = -0.2 \pm 0.1$. (auth)

39254 THE LARGE OPTICAL EXTENT OF M87. Arp, H. (Mount Wilson Observatory, Pasadena, Calif. Palomar Observatory, Pasadena, Calif.); Bertola, F. Astrophys. Lett., 4: 23-5 (July 1969).

Faint outer regions of the elliptical galaxy M87 have been photographically traced out beyond a diameter of 1 arc deg on the sky. Revisions of previous values of luminosity and mass are estimated and the problem of the origin of stars in the extremely low mass-density outer region is posed. (auth)

39255 SOLID-HYDROGEN-COATED GRAPHITE PARTICLES IN THE INTERSTELLAR MEDIUM. I. Wickramasinghe, N. C.; Krishna Swamy, K. S. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 144: 41-54(1969).

Solid-hydrogen-coated graphite particles may be expelled from regions of star formation into the general interstellar medium. The solid para-hydrogen mantles, which contain a small proportion of ortho-H_2, could be stable against evaporation in the general interstellar radiation field. They are also stable against physical and chemical sputtering in H I regions. Extinction efficiencies are calculated for solid hydrogen particles and for graphite particles with solid hydrogen mantles. Graphite core/solid hydrogen grains are capable of producing excellent agreement with the interstellar extinction observations from 20,000 to 1100 Å. The graphite core radius may be in the range $r_0 = 0.04$ to 0.06 μ and the solid hydrogen mantle radius in the range $r = 0.15$ to 0.25 μ. The albedo and phase function of these particles are consistent with the requirements imposed by the diffuse galactic light. (auth) (UK)

39256 5C3: A RADIO-CONTINUUM SURVEY OF M 31 AND ITS NEIGHBOURHOOD. Pooley, G. G. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 144: 101-27(1969).

Observations of the region of M 31 were made at Cambridge at 408 and 1407 MHz with resolutions of 80″ × 120″ and 23″ × 35″ respectively. A catalogue of 213 discrete sources with flux densities $S_{408} > 12 \times 10^{-29}$ W m^{-2} Hz^{-1} was prepared, although very few of these appear to be related to M 31. New techniques were used to examine the large-scale distribution of radiation from the nebula itself; the results presented show that the disk component of the continuum radiation is largely nonthermal at 408 MHz and originates almost entirely in the nucleus and the H II spiral arms. Its distribution suggests that the particle acceleration processes or magnetic field are closely linked with star formation and the presence of ionized gas. Two possible "spur" features may be associated with the companion galaxies M 32 and NGC 205, but the spurs previously reported were not confirmed. A brief comparison of the radio emission from M 31 and the Galaxy is made. (auth) (UK)

39257 INTERFEROMETRIC STUDY OF M31 NORTH-EAST ARM. Deharveng, J. M.; Pellet, A. (CNRS, Marseille). Astron. Astrophys., 1: 208-22(Feb. 1969). (In French).

The radial velocities of 253 points over M 31 were obtained by an interference method using the H_α line, with a mean dispersion of 26 Å/mm. The interferograms were made on the north-east arm of the galaxy at the Newtonian focus of the 77-inch telescope of the Haute-Provence Observatory and one at the 200-inch telescope of the Mount Palomar Observatory. A rotation curve was drawn, giving, by assuming a negligible expansion, the angular rotation velocity and the systemic velocity of the arm. There is some evidence of negligible expansion over the arm, and some possible explanations for the difference between various determinations of systemic radial velocity. (auth)

39258 GALACTIC BACKGROUND AT 4 GHz. Hirabayashi, H. (Tokyo Univ.); Ojima, T.; Morimoto, M. Nature (London), 223: 49-50(July 5, 1969).

Some results are presented from a study of the galactic continuum radiation between $l^{II} = 21$ and 31°, surveyed at 4,170 MHz using the 30-m parabolic antenna of the Kashima Station of the Radio Research Laboratories, with a beam width of 11 min of arc. The object was to produce a high-resolution map of the Milky Way at a high frequency. Comparison is made with the results of earlier studies, which were limited to below 2,700 MHz and beam widths >20 min of arc. The contour obtained corresponded to a brightness temperature of 0.1°K. About 30 discrete sources were detected, chiefly concentrated at the galactic equator, with a smooth background forming a "ridge" of galactic radio emission. After removing the contribution from the discrete sources, the brightness of the galactic "ridge" radiation was found to be about 1°K, with a half-brightness width of about 2° in b^{II}. If the galactic background radiation consists of nonthermal emission having a power law spectrum, plus optically thin thermal emission, the resulting spectrum should show a positive curvature; the observed spectrum indicated only a small amount of thermal emission contributing to the galactic background radiation. A previously implied spectral index variation indicating an appreciable amount of thermal emission concentrated at the galactic plane was not confirmed. (UK)

39259 CYGNUS X REGION. V. CATALOGUE AND DISTANCES OF OPTICALLY VISIBLE H II REGIONS. Dickel, H. R.; Wendker, H.; Bieritz, J. H. Astron. Astrophys., 1: 270-80(Mar. 1969).

A catalog of the H_α-emission nebulae in the western half of the Cygnus X region is presented. It contains positions, shapes, and surface brightnesses in H_α of the nebulae. For 90 objects, which also have radio data, the distances are derived from reddening data. These distances range from 1 kpc to greater than 4 kpc. A ring of filaments surrounding the entire Cygnus X region is briefly discussed. (auth)

39260 STUDY OF SEYFERT GALAXIES. III. IONIZATION MECHANISM. Souffrin, S. (Institut d'Astrophysique, Paris). Astron. Astrophys., 1: 414-26(Apr. 1969). (In French).

In the two preceding articles of this series, the spectra of the nuclei of 3 Seyfert galaxies were described, and the physical conditions of the emissive regions were established. In this third article, the problems of the ionization mechanism are considered. This problem is directly related to the energy injection process in the gas. Each of the mechanisms is considered in detail. (auth)

39261 KINEMATIC STUDY OF IONIZED HYDROGEN IN M51. Carranza, G.; Crillon, R.; Monnet, G. (Observatoire, Marseille). Astron. Astrophys., 1: 479-91(Apr. 1969). (In French).

Messier 51 was observed in H_α light through a narrow band interference filter. 109 detected H II regions were cataloged. Radial velocities were obtained by an interference method using a Pérot–Fabry interferometer, with a dispersion of 25 Å/mm. The rotation curve was drawn up to 4.6′ from the nucleus. The mass within 4.6′ is $M_t = 2.4 \times 10^{10}\ M_\odot$, using a distance of 4 Mpc. The large noncircular motions previously found in the nuclear regions by Burbidge, 1964, were confirmed. (auth)

39262 HIGH-RESOLUTION OBSERVATIONS OF A HIGH-LATITUDE NEUTRAL-HYDROGEN CONCENTRATION. Verschuur, G. L. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. Astrophys., 1: 473-5(Apr. 1969).

Maps of integrated hydrogen density, dispersion, and velocity of a discrete neutral hydrogen concentration at galactic longitude ~103°, latitude ~69° are presented and briefly discussed. The kinetic temperature of this cloud may well be of the order of 100°K or less, and it could be magnetically contained. (auth)

39263 KINEMATIC STUDY OF IONIZED HYDROGEN IN NGC 4449. Crillon, R.; Monnet, G. (Observatoires, Marseille). Astron. Astrophys., 1: 449-51(Apr. 1969). (In French).

51 H II regions were detected and cataloged in NGC 4449 from a plate taken in Hα light through a narrow band interference filter. Radial velocities were obtained by an interference method using a Pérot–Fabry interferometer with a dispersion of 25 Å/mm, up to 100″ from the center. Velocities have a dispersion of ±40 km s^{-1}, and show no appreciable rotational component. (auth)

39264 STUDY OF NUCLEI OF SEYFERT GALAXIES. II. PHYSICAL DESCRIPTION. Souffrin, S. (Institut d'Astrophysique, Paris). Astron. Astrophys., 1: 305-20(Mar. 1969). (In French).

The physical conditions in the nuclei of 3 Seyfert galaxies were studied. They were deduced from line intensities. In two of these objects, NGC 4151 and NGC 3516, the permitted lines have very broad wings whereas the forbidden lines are reduced to their central core. If the Doppler effect may be the cause of the broadening, probably the permitted and the forbidden lines are formed in different regions. The regions are considered separately. (auth)

39265 HYDROMAGNETIC STABILITY OF A SPIRAL ARM EMBEDDED IN A GRAVITATING MEDIUM. Aggarwal, Meera; Bhowmick, Gita; Talwar, S. P. (Univ. of Delhi). Astron. Astrophys., 1: 374-9(Apr. 1969).

The problem of instability of a self-gravitating, incompressible cylinder embedded in an external gravitating medium is investigated using the normal-mode analysis. Uniform axial magnetic fields are assumed to exist both in the interior and the exterior regions. Effect of a possible relative slippage is also incorporated. Stability criteria are obtained and their bearing on the existence of spiral arms discussed. It is found that the effect of external gravitating matter of density less than the spiral-arm density is to lengthen the time and the wavelength of the mode of maximum instability, whereas a higher density than within results in an instability similar to Rayleigh–Taylor instability for all wavelengths. Magnetic field and tangential slippage have, however, stabilizing and de-stabilizing influence, respectively. It is concluded that possible tangential slippage between the spiral arm and the galactic matter outside, and particularly the gravitating nature of the latter have a profound influence on the stability of a spiral arm. (auth)

39266 FORMATION OF GALAXIES FROM HYDROGEN GAS. Hirasawa, Toshiaki; Aizu, Ko; Taketani, Mituo (Rikkyo Univ., Ikebukuro, Japan). Progr. Theor. Phys. (Kyoto), 41: 835-8 (Mar. 1969).

The problem of whether galaxies can be formed from gas containing only the original elements (H and He), and, in particular, from pure hydrogen gas is briefly examined. (TSS)

39267 FORMATION OF H_2 AND GALAXIES IN THE HOT UNIVERSE. Takeda, Hidenori; Sato, Humitaka; Matsuda, Takuya (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 840-1(Mar. 1969).

The evolution of H_2 abundance in the uniform medium is shown, in contrast with the works of Saslaw et al. (Nature, 216: 976(1967)) and Peebles et al. (Astrophys. J., 154: 891(1968)), in which they calculated the products of H_2 in dense clouds. The aim is to find the critical epoch before which the formation of H_2 was prevented, even in the dense cloud, by photodissociation. (TSS)

39268 STELLAR GROUP Ba 6. Kiral, A. (Univ., Basel). Astron. Astrophys., 2: 22-4(May 1969). (In German).

Ba 6 is probably a physical group. The distance, 2100 pe, was determined by three-color photometry in the RGU system. (auth)

39269 GALACTIC CLUSTER NGC 2254. Kiral, A. (Univ., Basel). Astron. Astrophys., 2: 25-7(May 1969). (In German).

The distance of 2200 pe and the color excess E(G–R) of +0.45 were determined with the aid of three-color photometry in RGU system. A strong evolutionary effect is present. (auth)

39270 KINEMATIC STUDY OF IONIZED HYDROGEN IN NGC 4631. Crillon, R.; Monnet, G. (Observatoires, Marseille). Astron. Astrophys., 2: 1-5(May 1969). (In French).

The Magellanic-like galaxy NGC 4631 was observed in Hα light through a narrow-band interference filter; 88 H II regions were detected and cataloged. Radial velocities were obtained by an interference method using a Pérot–Fabry interferometer with a dispersion of 25 Å/mm. The rotation curve was drawn up to 6′ from the center. The total mass of the galaxy is $M_t \simeq 3.5\ 10^{10}\ M_\odot$. The center of symmetry of the optical rotation curve is 1′ away from the rotation curve of neutral hydrogen. The bar-like motions mentioned by de Vaucouleurs (1963) were not found. On the other hand, the radial velocity of the south–east H II regions outside the plane of the galaxy is 50 km s^{-1} lower than that of the neighboring regions in the galactic plane; this can be interpreted as an ejection of matter. (auth)

39271 REMARKS ON THE DISTANCE OF THE ASSOCIATION I PUPPIS AND THE CLUSTER NGC 2467. Grubissich, Claudio (Univ., Padua). Astron. Astrophys., 2: 245(June 1969). (In German).

The value of $R = A_v/E\ (B-V)$, derived from members of the association I Pup, lies between 1.8 and 3.9 depending on the luminosity calibration of the MK classification. The distance of I Pup is 2.3 kpc if R = 3.0; it belongs then into the spiral arm +I. (auth)

39272 SHORT-WAVELENGTH OSCILLATIONS OF COLD-DISK GALACTIC MODELS. Hunter, C. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 157: 183-96(July 1969).

A WKBJ analysis is given of the free oscillations of cold, thin-disk galactic models. Asymptotic approximations to the frequencies and forms of oscillations of short wavelength both in and perpendicular to the plane of the disk are obtained. The short-wavelength oscillations in the plane are never steady but either grow or decay in amplitude with time. Moreover, provided the angular velocity of disk material decreases from the center outward, the non-axisymmetric oscillations that grow on the linear theory have the form of leading spirals. The results on the planar modes in a cold disk extend considerably beyond, but are compatible with, those obtained in earlier investigations. (auth)

39273 OBSERVATIONS OF GALAXIES WITH LARGE AMOUNTS OF DUST. III. VELOCITY FIELD IN NGC 3077. Demoulin, Marie-Helene (Univ. of California, San Diego). Astrophys. J., 157: 81-5(July 1969).

NGC 3077 is a small Irr-II galaxy. Spectra taken in various directions do not show any velocity differences larger than the precision of the measurements, except in the direction P.A. = 150°, and the small velocity gradient in this direction cannot be interpreted as rotation. (auth)

39274 OBSERVATIONS OF GALAXIES WITH LARGE AMOUNTS OF DUST. II. ROTATION AND MASS OF NGC 3593. Demoulin, Marie-Helene (Univ. of California, San Diego). Astrophys. J., 157: 75-80(July 1969).

Direct photographs have shown the presence of large amounts of interstellar dust in the small peculiar SO galaxy NGC 3593. Although the spectral type reveals a young stellar population, there is no photographic evidence of early Population I. The emission lines are intense. Calculation of the mass from the velocity curve gives $M \simeq 3 \times 10^9\ M_\odot$, which is almost 5 times smaller than the mass of a late-type spiral. In contrast, the central density is 2×10^{-21} g cm^{-3}, which is as large as that of the more massive spiral galaxies. (auth)

39275 OBSERVATIONS OF GALAXIES WITH LARGE AMOUNTS OF DUST. I. THE GALAXY NGC 7625. Demoulin, Marie-Helene (Univ. of California, San Diego). Astrophys. J., 157: 69-73(July 1969).

NGC 7625 is a peculiar SO galaxy with a large amount of dust irregularly distributed. The spectrum is a very early-type one with the Balmer lines well visible in absorption from Hβ to H12.

Emission lines usually found in spiral galaxies are intense. The region 3.5 kpc in diameter rotates as a solid body and has a mass of 8×10^9 $M_\odot$. The total mass of the galaxy, which is 7 kpc in diameter, is $\simeq 1.6 \times 10^{10}$ $M_\odot$, and $M/L \simeq 2.5$. (auth)

39276 UBVRIHKL PHOTOMETRY OF THE CENTRAL REGION OF M31. Sandage, A. R. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Becklin, E. E.; Neugebauer, G. Astrophys. J., 157: 55-68(July 1969).

The nuclear region of M31 has similar brightness distributions, I(r), in BVR and K(2.2 μ) wavelengths. No nonthermal infrared excess exists in the nucleus of M31 above the limit of detection. A pronounced variation of U−B exists across the central ±60″ (±200 pc) which is not present in B − V or redder colors. U − B changes from 0.79 at the center to 0.60 at r = ±60″. Variation of the stellar luminosity function or metal abundance with distance from the center is a possible explanation, but neither is proved by the present data. Similar small-scale color gradients exist in M32, M81, and NGC 7331. The absolute energy distribution I(λ) shows a broad maximum which extends between 0.45 and 1 μ and decreases sharply on either side of the plateau. The broad-band multicolor data generally agree with the scanner data of higher spectral resolution which is available in the interval $0.33\ \mu < \lambda < 1.1\ \mu$. The surface brightness of M31 at 2.2 μ averaged over the central ±13 pc (7.62″ diameter) is 2.2×10^{-28} W m^{-2} Hz^{-1} per square second of arc. This is fainter by a factor of 2.4 than the 2.2 μ surface brightness of the Galactic center averaged over the equivalent linear diameter. The I(r) profile for M31 and the Galaxy is similar over the central ±400 pc — a fact which, combined with the higher surface brightness of the Galaxy, suggests that the Hubble type for the Galactic system is closer to an early Sb than to an Sc of the M33 or NGC 2403 type. (auth)

39277 NEW AND UNUSUAL VARIABLE STAR IN THE LARGE MAGELLANIC CLOUD. Wright, Frances W. (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Hodge, Paul W. Publ. Astron. Soc. Pac., 81: 238-47(June 1969).

A newly discovered variable star in the Large Magellanic Cloud (LMC) has a very unusual light curve that shows a broad, complex maximum lasting about 300 days and consists of a central, primary maximum with several secondary maxima. Subpulse periods are 250−700 days. There is only one observed bright maximum in 72 years. The star has the following photometric properties: B_{max} = 15.89 m, B_{min} = 18.70 m, $(B-V)_{min}$ = 1.50 m, M_B = −3.21 m (if a member of the Cloud). (auth)

39278 POSSIBILITY OF OSCILLATIONS ALONG AN AXIS OF SYMMETRY IN A GALAXY. Andrle, P. (Astronomical Inst., Prague). Bull. Astron. Inst. Czech., 20: 134-9(1969).

Oscillations along an axis of symmetry (z) are possible in a system possessing potential if and only if the terms proportional to ϖ vanish. Using an approximation method, and supposing the simpler potential, four approximation steps are taken. If the movement of a particle begins on the axis z, then the secular and mixed terms appear even in the case with no commensurabilities. The form of a general term in the expansion is determined. Supposing no linear terms in ϖ, the character of oscillations along the z-axis is discussed. The generality of oscillations in a plane of symmetry is also shown. (W.D.M.)

39279 PHYSIQUE ET EVOLUTION DES GALAXIES. (Physics and Evolution of Galaxies). Lequeux, J. Cours et Documents de Mathematiques et de Physique. New York, Gordon and Breach Science Publishers, Inc., 1967. 237p.

Topics discussed under the Milky Way include general structure, central regions, kinematics and dynamics, chemical composition, relation between the gas and the stars, and magnetic fields. Topics covered under the broad category of external galaxies include classification of galaxies, kinematic and dynamic properties and mass of galaxies, population and chemical composition, formation and evolution, and radio galaxies and quasars. (W.D.M.)

Cosmology

Refer also to abstract 39829.

39280 OBSERVATIONAL CONSTRAINTS ON A DISCRETE-SOURCE MODEL TO EXPLAIN THE MICROWAVE BACKGROUND. Penzias, A. A. (Bell Telephone Labs., Inc., Holmdel, N. J.); Schraml, J.; Wilson, R. W. Astrophys. J., 157: L49-51(July 1969).

An experimental limit to the small-scale anisotropy of the microwave background at 3.5 mm is presented. This upper limit corresponds to an rms variation in antenna temperature of 0.024°K observed with an effective beam size of 1.4×10^{-3} square degree. From this result it is concluded that the discrete-source models presented in a recent paper by Wolfe and Burbidge require a source density at least as great as that for all observed galaxies in order to explain the microwave background. (auth)

39281 THE LAGRANGIAN APPROACH TO THE GRAVITATIONAL INSTABILITY IN AN EXPANDING UNIVERSE. Narisi, Hidekazu (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 41: 686-94(Mar. 1969).

In order to remedy a defect found by Field and Shepley of Lifshitz's relativistic theory for the gravitational instability in an expanding universe, a new approach to the density perturbation mode is proposed. The defect lies in the fact that one solution of the third-order differential equation derived earlier by the author for the density contrast $K = \delta\epsilon/\epsilon_0$ has no physical meaning, where ϵ_0 is the unperturbed density of matter and radiation. The essence of the new approach is to adopt the Lagrangian coordinate condition which assures the comoving nature of coordinates even in the perturbed state, in place of Lifshitz's condition which becomes the former condition only when p_0 (the unperturbed pressure of matter and radiation) vanishes. It is shown that the differential equation for K is of the second order even when $p_0 = \epsilon_0/3$ and is reduced to Bonnor's Newtonian equation when $p_0 = 0$. It is shown further that, under some favorable condition, the growth rate of K is the highest at the stage $p_0 = \epsilon_0/3$, i.e., $K \propto t$ which does not necessarily hold in Lifshitz's original theory, where t is the cosmic time. Also examined is how the density perturbation depends sensitively on selection of coordinate conditions by imposing another coordinate condition. (auth)

39282 INTERGALACTIC HYDROGEN. Peebles, P. J. E. (California Inst. of Tech., Pasadena). Astrophys. J., 157: 45-54(July 1969).

If the Universe contains an appreciable amount of atomic hydrogen not bound up in ordinary galaxies, it may be reasonable to suppose that this material is not uniformly distributed but is, instead, incorporated in gravitationally bound clouds that happen to have been unable to complete the course of evolution to star systems. In this case, the available observational limits on the mean mass density due to intergalactic hydrogen must be corrected for the effects of self-absorption within the clouds. Taking this effect into account, the Gunn−Peterson test limits the abundance of atomic hydrogen to about 3% of that needed to close the Universe, unless the clouds have unusual and perhaps unlikely properties. The more direct tests based on 21-cm emission and absorption apparently would permit the contribution by atomic hydrogen to be as large as 30% of the critical mass density. (auth)

39283 EQUATION OF STATE OF NEUTRAL MATTER AND FLUCTUATIONS. Zel'dovich, Ya. B. Zh. Eksp. Teor. Fiz., 56: 1968-75(June 1969). (In Russian).

The equation of state of truly neutral matter consisting of neutral particles and equal amounts of charged particles and antiparticles is considered. The pressure may exceed a third of the energy density in the presence of particle and antiparticle repulsion; however at high temperatures it approaches this value due to the dominating contribution of weakly interacting particles. The density fluctuations are characterized by a universal dependence of specific entropy for any equation of state. The fluctuations of the electric charge correspond to the principle and equal distribution of energy in degrees of freedom. (auth)

39284 EXACT ROBERTSON-WALKER COSMOLOGICAL SOLUTIONS CONTAINING RELATIVISTIC FLUIDS. Vajk, J. Peter (Univ. of California, Livermore). J. Math. Phys. (N. Y.), 10: 1145-51(July 1969).

A new derivation of the Robertson−Walker metrics is presented which elucidates the relationship between these spatially homogeneous and isotropic models and certain spatially homogeneous but anisotropic models ("three-cylinder universes"). The evolutionary equations for Robertson−Walker models containing as many as four distinct noninteracting relativistic fluids (each obeying a gamma-law equation of state) are examined, and 25 exact closed-form solutions of this type are presented explicitly. (auth)

39285 ZERO-POINT ENERGY AND CONTINUOUS CREATION OF MATTER IN AN EXPANDING UNIVERSE. Kumar, N. (National Chemical Lab., Poona). Progr. Theor. Phys. (Kyoto), 41: 382-90(Feb. 1969).

A purely kinematic model of the Universe is considered that is described a priori by, (i) the Robertson−Walker space−time metric, (ii) the classical conservation law for energy−mass, and (iii) the observational fact of uniform Hubble expansion. It is shown that continuous creation of matter takes place in such a Universe as a direct consequence of a secular quantum effect, provided that the physical vacuum is treated as the ground state of a certain quantized field obeying Bose statistics. Under the

adiabatic hypothesis, the zero-point energy content per unit proper volume of the physical vacuum decreases parametrically (i.e., as a function of a time-dependent cutoff parameter) due to the cosmological redshift, concomitant with the Hubble expansion. This secular zero-point energy defect reappears necessarily as an accession of observable energy–mass (so as to satisfy the conservation law) and may be expected to compensate for the material rarefaction due to the universal expansion. The observable energy–mass density $\rho(t)$ at any epoch t, normalized with respect to its value $\rho(0)$ at the epoch $t = 0$, is given by a simple equation $\xi_\eta(t) \equiv \rho(t)/\rho(0) = (1+\eta)e^{-3Ht} - \eta e^{-4Ht}$, where η is an adjustable parameter (dimensionless) and H the Hubble constant. Based on certain heuristic reckonings, the age T_0 of the Universe is shown to be given by $T_0 = H^{-1} \ln 4/3$, which is, remarkably enough, independent of η. (auth)

Planetary Phenomena

39286 OBSERVATIONS OF LOCALIZED 5-MICRON RADIATION FROM JUPITER. Westphal, J. A. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astrophys. J., 157: L63-4(July 1969).

Localized thermal emission from Jupiter has been observed at 5 μ. During April and May 1969 peak brightness temperatures of at least 310°K were associated with narrow elongate regions between approximately 5° and 20°N. latitude. (auth)

39287 JUPITER'S DECAMETRIC ROTATION PERIOD. Donivan, Frank F.; Carr, Thomas D. (Univ. of Florida, Gainesville). Astrophys. J., 157: L65-8(July 1969).

The mean value of Jupiter's rotation period over an assumed 11.86-year drift cycle was found to be 9 hr 55 m 29.73 ± 0.04 s. The position of source A in a central-meridian-longitude system based on the new rotation period displayed a correlation with the Jovicentric declination of the Earth distinctly higher than its anticorrelation with the sunspot number, substantiating an earlier suggestion that the observed drift is a geometrical effect due to Jupiter's changing aspect in its orbit around the Sun. A model consisting of a single curved emission sheet fixed to the magnetic field can be made to account for the observed drifts of sources A and B. (auth)

39288 OBSERVATIONS OF SATURN, URANUS, AND NEPTUNE AT 11.13 cm. Gerard, E. (Observatoire, Meudon, France). Astron. Astrophys., 2: 246-8(June 1969).

From July to December 1968, the horizontally and vertically polarized E vectors of Saturn were measured and their intensities plotted as a function of longitude. The rotation period used was 10h38m50s. There may be a small horizontal linear polarization near $l = 90°$ corresponding to a somewhat higher total intensity but more observations are needed to check the reality of the effect. The disk temperature of Uranus was 180°K ± 40°K in the period December 1967–March 1968. An upper limit of 150°K can be set to the disk temperature of Neptune during the same period of observation. (auth)

39289 FARADAY EFFECT OF JUPITER'S RADIO BURSTS. Parker, G. D.; Dulk, G. A.; Warwick, J. W. (Univ. of Colorado, Boulder). Astrophys. J., 157: 439-48(July 1969).

From Faraday fringes present on swept-frequency records of Jupiter's decametric radio bursts the orientation of the polarization ellipse at the source can be determined. At Jupiter the ellipse has an orientation independent of frequency over the range 15 to 35 MHz, and its major axis has an average position angle of −25 ± 15° from the magnetic dipole axis for early source emissions. Apparently radiation is generated in one elliptically polarized magnetoionic mode. This ellipse undergoes no observable Faraday rotation in passing through the Jovian magnetosphere. The inferred upper limit to Jupiter's magnetospheric electron density is 10 cm^{-3}. (auth)

Atomic and Molecular Physics

Refer also to abstract 39626.

39290 SURFACE AND VACUUM PHYSICS INDEX. Volume 4, No. 5, 1969. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 120p.

226 articles on various aspects of surface and vacuum physics are listed. (M.O.W.)

39291 ATOME, KERNE, ELEMENTARTEILCHEN. (Atoms, Nuclei, Elementary Particles). Suessmann, Georg; Fiebiger, Nikolaus (eds.). Dies ist ein Buch der Zeitschrift UMSCHAU in Wissenschaft und Technik. Frankfurt am Main, Umschau Verlag, 1968. 317p.

Fourteen articles explaining the basic concepts on atoms, nuclei, and elementary particles are compiled. These 14 articles sketch the process of the microcosm phenomena, arranged in a sequence following the historical development. Separate abstracts were prepared for each of the articles. (J.S.R.)

For abstracts of individual papers see: 38317, 38318, 39112, 39344, 39345, 39591, 39641, 39642, 39679, 39764, 39774, 39889, 40135, and 40136.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 39555–39557 and 39879.

39292 (EGG-1183-1406) ANGULAR DIFFERENTIAL PHOTOELECTRIC CROSS SECTIONS. Tech Memo No. L-228. Churchhill, J. W.; Ziegler, L. H. (EG and G, Inc., Las Vegas, Nev.). Oct. 4, 1968. Contract AT(29-1)-1183. 361p. Dep. CFSTI.

Differential photoelectric cross-section graphs vs angle θ and energy for fourteen elements (Be, C, Al, Ti, Ni, Cu, Mo, Ag, Sn, Ta, W, Au, Pb, U), as calculated from both Sauter and Wüster and Gavrila, are given. The total photoelectric cross sections, as reported by Storm and Israel, as well as tables for both Sauter and Wüster and Gavrila for each element, are also shown. One set of graphs for aluminum with $\theta = 90°$ shows the differential-cross-section dependence on the polarization angle φ. (auth)

39293 (NP-17964) CRITICAL CURRENTS OF RELATIVISTIC ELECTRON BEAMS. Bogdankevich, L. S.; Zhelyazkov, I.; Rukhadze, A. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1969. 13p. Dep.

The problem of critical currents of relativistic electron beams in drift space is investigated. It is shown that the limiting current of an uncompensated beam, restricted by space charge, increases linearly with the growth of electron energy in the relativistic range. The critical currents in compensated beams are determined by the condition for emergence of electrostatic instabilities in the system. The critical currents increase with the growth of electron energy in the relativistic range as E^3. This makes possible the production of high currents in compensated electron beams. (auth)

39294 OPTICAL DETECTION OF ELECTRON POLARIZATION. Farago, P. S.; Wykes, J. S. (Univ. of Edinburgh). J. Phys., B (London), 2: 747-56(July 1969).

A method is suggested for measuring the polarization of low-energy electron beams by observing the polarization of the light emitted by mercury atoms following their excitation by electron impact. It is shown that the asymmetry of the left and right circularly polarized components of the 2537-Å radiation of the even isotopes is approximately equal to the longitudinal polarization of the incident electron beam. The efficiency of such a detector is estimated for incident electron energies near the excitation threshold, and its expected performance compares favorably with that of a typical Mott detector. Some distinctive advantages of the proposed method are pointed out. (auth) (UK)

39295 BACKSCATTERING OF keV HYDROGEN IONS IN SOLIDS. McCracken, G. M. (United Kingdom Atomic Energy Authority, Abingdon, Eng.); Freeman, N. J. J. Phys., B (London), 2: 661-8(June 1969).

By assuming that incident ions are scattered in a single wide-angle collision and that the energy loss in the solid is due only to interaction with electrons, an expression for the number of ions backscattered from a surface is derived. Measurements were made of the energy distribution of protons and deuterons backscattered from titanium and niobium. Good agreement was obtained between the measured and calculated energy distributions both in general shape and in the absolute values of the number of particles backscattered from titanium. In the case of niobium there was evidence that multiple scattering took place. (auth) (UK)

39296 ^{4}He CHARGE STATE FRACTIONS IN THIN CARBON FOILS. Spitzberg, L. A.; Jordan, J. A. Jr. (Rice Univ., Houston, Tex.). J. Phys., B (London), 2: 691-5(June 1969).

^{4}He charge state fractions were measured in the energy range from 0.65 to 3.80 MeV. High beam currents (~2 μA) were used and a photoelectric technique was employed to normalize the data. The results are in excellent agreement with those obtained by Armstrong et al. in 1965 and confirm the small difference between the charge state fractions measured in carbon and those measured in other foils. (auth) (UK)

39297 ENERGY-LOSS STRAGGLING OF A HELICAL ELECTRON BEAM IN A MAGNETIZED FOIL. Dupasquier, A.

(Politecnico, Milan. Consiglio Nazionale delle Ricerche, Milan). Phys. Rev., 182: 397-400(June 10, 1969).

The energy-loss process of a helical negatron or positron beam of a few MeV in a thin magnetized foil was studied. The straggling distributions were derived, taking into account spin-dependent terms of the Möller and Bhabha cross sections. These terms affect the shape of the straggling distributions by an amount that increases with increasing energy losses. Numerical calculations were carried out in some typical cases, which are of interest with a view to using the spin-polarization effect as a means of measuring the helicity of β rays. (auth)

39298 A FABRICATION METHOD OF MULTI-CAPILLARY NOZZLE FOR ATOMIC BEAM. Hasuyama, Hiroki; Wakuta, Yoshihisa (Kyushu Univ., Fukuoka). Genshikaku Kenkyu, 13: 623-6(Feb. 1969).

A simple method for fabrication of a multicapillary nozzle used in a polarized ion source is described. The multicapillary nozzle consists of a bundle of about two thousand capillaries of pyrex glass of 0.2 mm in outer diameter. The transparency is about 70%. (auth)

39299 RANGES AND IONIZATION ENERGY LOSSES OF PROTONS IN VARIOUS SUBSTANCES. Vasilevskii, I. M.; Karpov, I. I.; Petrukhin, V. I.; Prokoshkin, Yu. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 997-1008 (May 1969). (In Russian).

Ranges for 660-MeV protons in C, Al, Cu, Sn, and Pb were measured by the Bragg's curve method. Relative ionization energy losses of the protons in the energy interval from 100 to 600 MeV were determined for various substances using a differential ionization chamber. The experimental results are in agreement with the theoretical quantities at the following values of the ionization potential: $I_C = 82.5 \pm 1.3$ eV, $I_{Al} = 160$ eV, $I_{Cu} = 323 \pm 5$ eV, $I_{Sn} = 518 \pm 13$ eV, and $I_{Pb} = 826 \pm 14$ eV. (auth)

Atomic and Molecular Properties

Refer also to abstracts 39220, 39314, 39333, 39449, and 39621.

39300 SCF DIRAC–SLATER CALCULATIONS OF THE TRANSLAWRENCIUM ELEMENTS. Waber, J. T.; Cromer, D. T.; Liberman, D. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 51: 664-8(July 15, 1969).

Total energies of several configurations of the elements in the range of atomic numbers 104 to 132 were computed using the Liberman–Waber–Cromer program to determine the probable ground-state configurations. These calculations provide evidence for eka-actinium (s^2d) at 121, partial filling of the 6f shell through 124 and beginning of a new superactinide series at element 125, in which the 5g shells fill progressively as the atomic number increases. (auth)

39301 STABILITY OF 8p ELECTRONS IN SUPERHEAVY ELEMENTS. Mann, Joseph B. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 51: 841-2(July 15, 1969).

Relativistic Hartree–Fock calculations with complete exchange being carried out for superheavy elements ($Z \geq 118$) show that in every case the most stable ground-state configuration contains at least one 8p electron. It is suggested that this apparently anomalous stability of the 8p shell is probably caused entirely by relativistic effects. A note added in proof states that the spin–orbit coupling parameter for the 8p electron of element 121 was later determined by calculations to be approximately 8350 cm^{-1}, and the average energy of the $8p_{\frac{1}{2}}$ and $8p_{\frac{3}{2}}$ levels lies above that of the $8d_{\frac{3}{2}}$ and $8d_{\frac{5}{2}}$ levels by approximately 560 cm^{-1}. (A.G.W.)

39302 HARMONIC OSCILLATOR EXPANSIONS OF THE HYDROGEN ATOM. Kirwan, Donald F. (Univ. of Rhode Island, Kingston). J. Chem. Phys., 51: 857-8(July 15, 1969).

Convergence rates for properties of the hydrogen atom when using spherical harmonic-oscillator (HO) expansions were calculated. Results are reported as absolute relative errors plotted as a function of the number of HO quanta for energy, rms radius, square of the wave function overlap, and mean-square radius. (A.G.W.)

39303 RELATIVISTIC CORRECTIONS TO S_{-2} FOR ATOMIC HYDROGEN. Bartlett, M. L.; Power, E. A. (University Coll., London). J. Phys., A (London), 2: 419-26(July 1969).

It is shown that, to order α^2,

$$S_{-2} = \sum_j \frac{|\langle 0|z|j\rangle|^2}{E_j - E_0} = 4.499\ 752\ \ldots$$

for the dipole sum over Dirac states of the hydrogen atom. This compared with the value $\frac{9}{2}$ for the sum over Schroedinger states. (auth) (UK)

39304 LINEAR PROGRAMMING AND THE CALCULATION OF UPPER AND LOWER BOUNDS OF ATOMIC MEAN EXCITATION ENERGIES. Futrelle, R. P.; McQuarrie, D. A. (North American Rockwell Corp., Thousand Oaks, Calif.). J. Phys., B (London), 2: 640-6(June 1969).

Linear programming is used to calculate upper and lower bounds to the mean excitation energies I of hydrogen, helium, neon, argon, and krypton. Only the values of dipole oscillator strength sum rules are required. The bounds obtained for I are: H, $14.0 \leq I(eV) \leq 15.2$; He, $41.1 \leq I(eV) \leq 43.5$; Ne, $90 \leq I(eV) \leq 181$; Ar, $64 \leq I(eV) \leq 295$; Kr, $88 \leq I(eV) \leq 476$. These bounds are rigorous in that they are the greatest upper and least lower bounds consistent with the presently available values of the sum rules. (auth) (UK)

39305 INTERFEROMETRICALLY MEASURED THORIUM LINES BETWEEN 2747 AND 4572 A. Goorvitch, David (Ames Research Center, Moffet Field, Calif.); Valero, Francisco P. J.; Clua, Alicia L. J. Opt. Soc. Amer., 59: 971-5(Aug. 1969).

Interferometrically measured wavelengths are given for 278 thorium lines in the range 2747 to 4572 Å. The light source is a liquid-nitrogen-cooled hollow-cathode lamp with 1 torr of argon as the carrier gas. Each line is measured from interferograms taken with a Fabry–Perot interferometer having 20-, 40-, and 50-mm spacers, and the results are averaged after making the correction for dispersion of optical path. The combination principle is used as a test of the accuracy of the measurements. The average wavelength error is about one part in 3 to 6×10^7 and the average root-mean-square deviation is 1.6×10^{-4} Å between the results for the different spacers. The results are compared with those of different investigators and indicate a relative shift of $+4 \times 10^{-4}$ Å when the electrodeless discharge tube is compared with the hollow-cathode lamp. The origin of this shift is discussed and attributed partly to differences in the standards used to calibrate the interferometer and partly to differences in the light sources. (auth)

39306 OBSERVATIONS OF LAMB SHIFTS IN H USING SPATIALLY PERIODIC POTENTIALS. Hadeishi, T.; Bickel, W. S.; Garcia, J. D.; Berry, H. G. (Univ. of Arizona, Tucson). Phys. Rev. Lett., 23: 65-7(July 14, 1969).

Resonance effects between the $(3^2S_{\frac{1}{2}} - 3^2P_{\frac{1}{2}})$ levels in hydrogen atoms were observed by passing a beam of fast moving hydrogen atoms through spatially periodic potential barriers and causing velocity-dependent frequency tuning. The resonances permit the determination of level separations. (auth)

39307 PROBABILITY OF FORMATION OF $[(^3He)^+]_{4s}$ FOLLOWING BETA DECAY OF TRITIUM. Wexler, S.; Porter, F. T. (Argonne National Lab., Ill.). J. Chem. Phys., 50: 5428-9(June 15, 1969).

The probability of formation of the 4s state of $(^3He)^+$ in the beta decay of tritium was determined by measuring the 4s → 3p optical transition produced in the dissociation of the $(T\ ^3He)^+$ daughter formed indirectly in molecular tritium. (J.W.R.)

39308 AMPLIFICATION OF THE ELECTRON ELECTRIC DIPOLE MOMENT IN ATOMS. Ignatovich, V. K. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Theor. Fiz., 56: 2019-27(June 1969). (In Russian).

Amplification coefficients for the electron electric dipole moment (EDM) in U, Lu, Eu, Ce, Cs, Fe, and Cr are calculated with the purpose of determining the most suitable substance for experiments on determination of the EDM. The amplification coefficients are estimated in the quasi-classical approximation; Coulomb functions are employed. Numerical calculations show that the amplification coefficient increases with Z as Z^4. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstract 40110.

39309 POSITRON LIFETIMES IN CCl_4, $SiCl_4$, $GeCl_4$, AND $SnCl_4$. Sen, P.; Patro, A. P. (Saha Inst. of Nuclear Physics, Calcutta). Nuovo Cim., 62A: 514-18(July 21, 1969).

Measurements were made to determine the long-lived component, τ_2, and its intensity, I_2, of positrons decaying in CCl_4, $SiCl_4$, $GeCl_4$, and $SnCl_4$. The time spectra of CCl_4, $GeCl_4$ and $SnCl_4$ do not show any long component, at least up to four decades. The time spectrum of $SiCl_4$ shows a very long component of $\tau_2 = (3.26 \pm 0.06) \times 10^{-9}$ s with intensity $I_2 = 47\%$. The attempt to apply the Ore model to explain this large I_2 observed in $SiCl_4$ is not helpful. (auth)

39310 COUPLING OF μ-MESONIC AND ELECTRONIC HYPERFINE STRUCTURE IN AN ATOM. Otten, E.-W. (Univ., Heidelberg). Z. Phys., 225: 393-406(1969). (In German).

In calculating the hyperfine-structure interaction between a μ-mesic atom and a valence electron, the former can be treated as a pseudonucleus of charge (Z−1), since its radius is very small as compared to the one of the electronic wave function. The consequences of this concept as well as corrections to it are discussed in detail. The experimental possibility of rf spectroscopy of this hyperfine structure is pointed out. It is based on the destruction of the β-decay asymmetry of stopped polarized μ mesons at resonance. Special attention is paid to the one-electron system $(He^{++}\mu^-)e^-$. (auth)

39311 METASTABLE STATES OF $\alpha\pi^-e^-$, αK^-e^-, AND $\alpha\bar{p}e^-$ ATOMS. Russell, J. E. (Univ. of Cincinnati). Phys. Rev. Lett., 23: 63-4(July 14, 1969).

It is suggested that antiprotons could be used to test Condo's conjecture that the large mean cascade time for K^- mesons in atomic orbits in liquid helium is due to metastable states. (auth)

Collision Phenomena

Refer also to abstracts 39102, 39209, and 39390.

39312 (N-69-24208) SINGLE-ELECTRON CAPTURE BY MULTIPLY-CHARGED CARBON IONS AT ENERGIES BELOW 40 keV. Zwally, H. Jay (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Dec. 1968. 171p. (NASA-CR-100752; BN-582). CFSTI.

Total cross sections for single-electron capture by C^{4+} from the target gases of He, Ne, and Ar were measured at laboratory energies below 40 keV. The relative velocities of collision were in the near-adiabatic range of 1 to 8×10^7 cm/sec. Cross sections were measured for C^{2+} on He, Ne, and Ar and for Kr^{3+} on He. The experimental method was to pass an ion beam through a thin gas target under single-collision conditions and to separate and measure the fast collision products according to their charge state. The results are interpreted in terms of the pseudo-crossing of the adiabatic potential-energy curves for the initial and the final states. A comparison is made with a cross-section function, derived from the limited Landau–Zener theory, using an empirical value of the interaction matrix element based on previous theoretical and experimental results. (auth) (STAR)

39313 VIBRATIONAL TRANSITION PROBABILITIES FOR THE MORSE OSCILLATOR. Endres, Paul F. (Univ. of Rochester, N. Y.). J. Chem. Phys., 51: 477-9(July 15, 1969).

The method of Shuler and Zwanzig has been used to calculate the vibrational transition probabilities for a Morse oscillator suffering an impulsive, colinear collision with an atom. Results are presented for the system H_2 colliding with D. (auth)

39314 QUENCHING OF METASTABLE HYDROGEN ATOMS BY MOLECULAR IMPACT. Gersten, Joel I. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 51: 637-9 (July 15, 1969).

A theory for the quenching of metastable hydrogen by molecular gases is presented. It is shown that the rather large cross sections observed experimentally by Fite et al., can be accounted for by assuming the quenching to be due to the dipole–multipole interaction. Comparison with experiment gives fair agreement. (auth)

39315 EIGENFUNCTION ANALYSIS OF THE HEAVY ELECTRON MODEL OF COMPTON AND INVERSE COMPTON SCATTERING. Pomraning, G. C.; Froehlich, R. (Univ. of California, [San Diego]. Gulf General Atomic Inc., San Diego, Calif.). Astron. Astrophys., 1: 286-96(Mar. 1969).

The equation of radiative transfer due to Fraser (1966), including effects of absorption, emission, and Compton and inverse Compton scattering, is put into a form which admits an eigenfunction expansion as the treatment of the frequency variable. The appropriate eigenvalue problem is studied both analytically and numerically. Asymptotic series for the eigenfunctions about zero and infinite frequencies are given and shown to truncate for certain functional forms of the absorption coefficient. A numerical method for computing eigenvalues and eigenfunctions, valid for a large class of absorption coefficients, is presented. Sample numerical results are given to demonstrate the success of the numerical method. (auth)

39316 A NEW RESONANCE IN THE e–H_2 SCATTERING. Ehrhardt, H.; Weingartshofer, A. (Univ., Mainz). Z. Phys., 226: 28-33(1969).

A short-lived compound state of the system e–H_2 in the energy region from 13.5 to 15 eV has been investigated. It disintegrates preferably into the $C^1\Pi_u v = 0, 1, 2, 3, \ldots$ vibrational states of H_2. Excitation functions and angular dependences of these states have been measured. The H_2 vibrational levels are situated at 13.63, 13.93, 14.20, 14.70, 14.92, ... eV. The shape of the potential-energy curve and the internuclear distance of the compound state should be very similar to that of the $C^1\Pi_u$ or $D^1\Pi_u$ state of H_2. (auth)

39317 RESONANT DIFFERENTIAL SCATTERING OF ELECTRONS BY HELIUM. Gibson, J. R.; Dolder, K. T. (Univ. of Newcastle-upon-Tyne, Eng.). J. Phys., B (London), 2: 741-6 (July 1969).

The resonant differential scattering of electrons by helium was investigated for energies close to 19.3 eV. The data-logging technique employed gave exceptionally high signal-to-noise ratios. Analysis of the results gave $\delta_0 \simeq 111°$, $\delta_1 \simeq 17°$, and $\delta_2 \simeq 3°$ for the first three phase shifts for potential scattering at the resonance energy, and 8 MeV for the natural width at half-height. Structure was observed at 19.45 ± 0.05 eV, which had the properties of a p-wave resonance with a natural width of order 0.25 MeV. (auth) (UK)

39318 VARIATIONAL CALCULATIONS OF RESONANCE WIDTHS IN e–H SCATTERING. Bottcher, C. (Queen's Univ., Belfast). J. Phys., B (London), 2: 766-71(July 1969).

A variational method for resonance widths suggested by Bransden and Dalgarno (1952, 1953) is examined in detail, and its formal equivalence to other theories is demonstrated. The equations that result from the use of a linear combination of trial functions are developed. Calculations are presented for several low-lying resonances in H^- by use of simple representations of the quasi-bound wave functions. The widths are in reasonable agreement with those found by the close-coupling method. (auth) (UK)

39319 SEARCH FOR A POSSIBLE ISOTOPE EFFECT IN CHARGE-CHANGING COLLISIONS INVOLVING HYDROGEN AND DEUTERIUM. Salvatelli, E. R.; Lantschner, G.; Meckbach, W. (Univ. Nacional, Cuyo, Argentina). J. Phys., B (London), 2: 772-6(July 1969).

Charge equilibrium fractions $F_{1\infty}$, $F_{0\infty}$, and $F^-_{1\infty}$ and relative charge-changing cross sections σ_{10} and σ_{01} were measured for the four possible combinations among hydrogen and deuterium beams and targets, namely H^+-D_2, H^+-H_2, D^+-D_2 and D^+-H_2. Within experimental errors of less than 0.3% for $F_{0\infty}$, 1.2% for $F_{1\infty}$, and 2% for both $F^-_{1\infty}$ and the relative cross sections, no systematic differences for these isotope combinations were found in the velocity range 1.38×10^8 to 2.24×10^8 cm sec^{-1}. Neglecting the small negative charge fraction, the ratio σ_{10}/σ_{01}, given by $F_{0\infty}/F_{1\infty}$, agreed to within 1.5% for the different combinations studied. (auth) (UK)

39320 CONCERNING DETERMINATIONS OF THE DRIFT VELOCITY AND LATERAL DIFFUSION OF POSITIVE IONS IN HYDROGEN. Fleming, I. A.; Tunnicliffe, R. J.; Rees, J. A. (Univ. of Liverpool). J. Phys., B (London), 2: 780-9(July 1969).

In a number of investigations of the mobilities of hydrogen ions in hydrogen, zero-field mobilities approximately equal to 12.6 cm^2 V^{-1} sec^{-1} have been recorded, and it seems to be currently accepted that these are inaccurate determinations for H_3^+ ions, the zero-field mobility of which is approximately equal to 11.1 cm^2 V^{-1} sec^{-1}. It is suggested that the ions of mobility approximately equal to 12.6 cm^2 V^{-1} sec^{-1} are H_3O^+ ions. Approximate values for the lateral diffusion of the H_3O^+ ions in hydrogen are reported, together with lower limits for the lateral diffusion of H^+ ions. The implications of the identification of the ions of mobility approximately equal to 12.6 cm^2 V^{-1} sec^{-1} as H_3O^+ ions in studies of recombination in hydrogen are briefly considered. Data for the drift velocity and lateral diffusion of potassium ions in hydrogen are also reported for $2.0 \times 10^{-17} < E/N < 300 \times 10^{-17}$ V cm^2 at room temperature. (auth) (UK)

39321 SYMMETRIC CHARGE TRANSFER INVOLVING $^2P_{\frac{3}{2}}$ AND $^2P_{\frac{1}{2}}$ Kr^+ AND Xe^+ IONS. Davies, G. R. (University Coll., London); Gilbody, H. B. J. Phys., B (London), 2: 814-16(July 1969).

A technique that employs a carefully controlled electron-impact ion source was used to show that the two ground doublet states of both Kr^+ and Xe^+ undergo symmetric charge transfer with near equal efficiency in the energy range 300 to 2500 eV. (auth) (UK)

39322 EXCITATION IN 100- TO 400-keV Ar^+–Ar COLLISIONS. Robinson, J. M.; Gilbody, H. B. (Queen's Univ., Belfast). J. Phys., B (London), 2: 817-(July 1969).

A Doppler-shift analysis of the emissions arising from excitation in fast Ar^+–Ar collisions shows that collisions involving charge transfer simultaneous with excitation and direct excitation of fast Ar^+ ions are of comparable importance. (auth) (UK)

39323 IONIZATION OF ATOMIC HYDROGEN BY PROTON IMPACT. Salin, A. (Observatoire de Paris, Meudon, France). J. Phys., B (London), 2:, 631-40(June 1969).

Rudge and Seaton's (1964) theory of impact ionization is extended

to ion–atom collisions. Calculations are carried out for the angular and energy distribution of electrons ejected from hydrogen atoms by high-energy protons. The results differ appreciably from those of the conventional Born approximation when the ejected electron has a velocity close to that of the incident proton. (auth) (UK)

39324 IONIZATION OF HELIUM BY HIGH-ENERGY PROTONS. Bell, K. L.; Kingston, A. E. (Queen's Univ., Belfast). J. Phys., B (London), 2: 653-60(June 1969).

The Born cross section for the proton ionization of helium is calculated using both the length and velocity formulations of the Born matrix elements. The ground state of helium is represented by a six-parameter correlated wave function; polarized-orbital wave functions are employed for the l = 0, 1, and 2 partial waves of the continuum state, and Hartree–Fock wave functions for the l = 3, 4, and 5 partial waves. There is good agreement between the calculated cross section and experiment for incident proton energies greater than 100 keV. (auth) (UK)

39325 ASYMPTOTIC SOLUTIONS OF THE COUPLED EQUATIONS FOR ELECTRON COLLISIONS WITH POSITIVE IONS. Norcross, D.; Seaton, M. J. (University Coll., London). J. Phys., B (London), 2: 731-40(July 1969).

Previous work on techniques for the computation of functions that are solutions of the coupled equations for electron collisions with positive ions and that have known asymptotic forms is reviewed. A new iterative technique is described, and some illustrative numerical results are obtained. (auth) (UK)

39326 ON THE THEORY OF THE SCATTERING OF EXCITED ALKALI ATOMS BY INERT-GAS ATOMS. Grawert, G. (Univ., Marburg, Ger.). Z. Phys., 225: 283-92(July 1969). (In German).

Calculations of the cross sections for collision-induced transitions between Zeeman sublevels of excited alkali metal atoms are proposed, which are independent from dynamical models. The transition matrix describing collision-induced deorientation of the orbital angular momentum but not including spin change of the valence electron is analyzed considering invariance principles only. Consequently the cross sections for depolarizing collisions are given by two dynamical parameters. The full transition matrix describing deorientation of the orbital angular momentum as well as of the spin of the valence electron is analyzed in the same way. In this general case the depolarizing cross sections are given by six dynamical parameters. (auth)

39327 ELECTRONIC AND IONIC IMPACT PHENOMENA. VOLUME 2. ELECTRON COLLISIONS WITH MOLECULES: PHOTOIONISATION. SECOND EDITION. Massey, H. S. W. International Series of Monographs on Physics. Oxford, Clarendon Press, 1969. 668p. 200s.

The subject is discussed under the following main headings: Electron collisions with molecules (total and elastic scattering; excitation of vibration and rotation–analysis of swarm experiments at low energies; electronic excitation, ionization, and attachment–general theoretical considerations and experimental methods–applications to specific molecules); collisions involving electrons and photons (radiative recombination, photoionization, and bremsstrahlung; photodetachment and radiative attachment). (UK)

39328 ANALYSIS OF LOW-ENERGY ATOMIC AND MOLECULAR COLLISIONS: SEMICLASSICAL ELASTIC SCATTERING CALCULATIONS AND DECONVOLUTION OF DATA. Ioup, George Elias. Gainesville, Fla., Univ. of Florida, 1968. 343p. Thesis.

A brief review of the levels of approximation that may be used in the calculation of elastic differential scattering cross sections for known central-force interaction potentials is given. Included are the quantum partial wave formulas, the semiquantal summation procedure, semiclassical methods, and classical results. The range of validity of each is discussed. Special attention is given the semiclassical treatment, which is the main topic. In particular, the need for the accurate evaluation of derivatives of the classical deflection function is established. The derivations of integral expressions for the second and third derivatives of the classical deflection function are given. Also presented is essential information for the rapid and precise determination of these derivatives by numerical quadrature on a digital computer. Transformations of integrals to facilitate this evaluation are included. Then the actual calculation of a low-resolution semiclassical elastic differential scattering cross section is treated. The choice of an interaction potential is discussed as well as the necessary modifications of the general semiclassical formulas. The computer programs used and tables of results are also given. In addition, the problem of improving experimental resolution mathematically is attacked. It was found that a significant increase in resolution could be obtained. This was done by applying the techniques of numerical smoothing and deconvolution to experimental data. A mathematical model for loss of experimental resolution is developed and indications of its very general nature are given. Some effort is devoted to the mathematical aspects of deconvolution and the important work of other authors is reviewed. Sampled functions play a central role in these developments and are discussed. An examination of noise and techniques for its removal (smoothing) follow. Further considerations, which arise in actual applications, are then considered in detail. An illustrative analysis of an experiment, such as must be performed prior to deconvolution of data, is given. Finally, the results of tests performed by applying iterative smoothing and deconvolution to beam-collision data are presented. The computer programs employed are included. Suggestions are made for the use of an interpolation formula from sampled function theory. (Diss. Abstr.)

39329 DETERMINATION OF THE TOTAL EXCITATION CROSS SECTION IN NEON BY COMPARISON OF THEORETICAL AND EXPERIMENTAL VALUES OF TOWNSEND'S PRIMARY IONIZATION COEFFICIENT. Thomas, W. R. L. (Univ. of Wales, Eng.). J. Phys., B (London), 2: 551-61(May 1969).

It is shown that previous theories relating transport and ionization coefficients to fundamental collisional processes between electrons and atoms are incomplete, and can, in some cases, lead to considerable error. The influence of diffusion and injection of new electrons into the discharge through ionization are taken fully into account in the development of a more rigorous Boltzmann equation, which is solved numerically. A total excitation cross section is found, which gives good agreement between experimental values of Townsend's primary ionization coefficient and theoretically predicted values over almost the whole range of E/p_0 where experiments have been carried out. The cross section covers a range of electron energy up to 50 eV, and is about 20% lower than the experimental cross section of Maier–Leibnitz. (auth) (UK)

39330 EXCHANGE CORRECTION TO THE AMPLITUDE OF DIRECT SCATTERING OF ELECTRONS FROM ATOMS. Ochkur, V. I. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 534-5(Dec. 1968).

Translated from Opt. Spektrosk., 25: 964-5(Dec. 1968).

Calculations were made for the 1s–2s and 1s–2p transitions in hydrogen using the Born approximation. (M.O.W.)

39331 INTRUSION OF 35 keV H_1^+ IONS INTO Mo, Ag, Ta, Pt METALS, AND DESORPTION OF INTRUDED HYDROGEN AT TEMPERATURE INTERVAL 78 TO 300°K. Katrich, N. P. At. Energ. (USSR), 26: 307-9(Mar. 1969). (In Russian).

Reactions of 35-keV H^+ ions with Mo, Ag, Ta, and Pt metals were studied under conditions of ultrahigh vacuum ($\leq 1 \times 10^{-9}$ torr). Graphic presentation is given of the intrusion coefficient η as a function of the number of intruded ions N in molybdenum, silver, tantalum, and platinum at 78 and 300°K. The results showed that the process of fast-ion intrusion depends on the type of metal not only at high temperatures $T \geq 300$°K but even at low temperatures. The character of the hydrogen bond with the metal atoms plays the most important role in this process. A stable hydrogen bond in platinum was observed only at temperatures considerably lower than 300°K. (R.V.J.)

39332 EXCITATION OF ROTATIONAL AND VIBRATIONAL MOTION OF N_2^+ IONS PRODUCED IN COLLISIONS BETWEEN INERT GAS ATOMS AND NITROGEN MOLECULES. Polyakova, G. N.; Erko, V. F.; Fogel, Ya. M.; Zats, A. V.; Fizgeer, B. M. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz., 56: 1851-5(June 1969). (In Russian).

Rotational and vibrational excitation of N_2^+ ions produced in collisions between N_2 and 5- to 30-keV He, Ne, Ar, Kr, and Xe atoms is investigated. The degrees of excitation of rotational and vibrational motions in N_2^+ ions by similar atoms or ions are compared. From this comparison it can be concluded that rotational and vibrational excitation of N_2^+ ions due to atomic collisions is greater than that due to ion collisions. (auth)

39333 AUTOIONIZATION STATES IN ARGON. Ogurtsov, G. N.; Flaks, I. P.; Avakyan, S. V. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 57: 27-37(July 1969). (In Russian).

Results of investigation of the energy spectrum of electrons liberated in collisons between protons and argon atoms are presented. The electron spectrum was investigated for electron energies E_e, lying between 5 and 300 eV and a proton energy T = 20 keV. The structural part of the spectrum is identified and its nature is explained. It is shown that the observed spectral lines are due to auto-ionization transitions in argon. More precisely, the structure of the low-energy part of the spectrum (E_e = 5 to 16 eV) is due to excitation of the Ar M shell; the spectral range corresponding to electron energies E_e = 28 to 70 eV is related to

Auger transitions of the Koster–Kronig type and the spectral ranges for electron energies 100 to 240 and 240 to 300 eV are due to excitation of the L_{23} and L_1 subshells in Ar respectively. It is pointed out that $3s3p^54s4p$ auto-ionization states may be produced, their decay producing excited Ar^+ ions. Spectral lines related to Auger transitions from the initial states in which the inner electron goes over into the excited optical level were detected due to three-electron Auger transitions have also been observed. (auth)

39334 POLARIZATION OF $^2S_{\frac{1}{2}}$ GROUND STATE OF EVEN ISOTOPES ON Hg^+ BY STEPWISE ELECTRON IMPACT. Liu, C. H.; King, R. L.; Stroke, H. H. (New York Univ., N. Y.). Phys. Rev. Lett., 23: 209–11(Aug. 4, 1969).

The $6s^2S_{\frac{1}{2}}$ ground ionic state of even isotopes of mercury was polarized in a stepwise excitation process from the atomic $6s^2\ ^1S_0$ ground state via the metastable $6s6p\ ^3P_2$ state. The latter was optically pumped with polarized 5461-Å ($6s7s\ ^3S_1 - ^3P_2$) radiation. Paramagnetic resonance, observed by monitoring the change in intensity of the relatively intense 2851-Å ($5d^96s^2\ ^2D_{\frac{5}{2}} - 5d^{10}6s\ ^2S_{\frac{1}{2}}$) electric quadrupole resonance radiation, was used to determine the polarization of the even-isotope ground-state ion to be 15%. If one assumes conservation of spin angular momentum, this process should yield highly polarized electrons. (auth)

39335 EXCITATION OF FAST HYDROGEN ATOMS IN THE 2s, 2p, AND 3p STATES DUE TO COLLISIONS WITH NOBLE GAS ATOMS. Orbeli, A. L.; Andreev, E. P.; Ankudinov, V. A.; Dukel'skii, V. M. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 57: 108–16(July 1969). (In Russian).

Intensities of the L_α and L_β Lyman lines emitted in collisions between fast hydrogen atoms (5 to 40 keV) and He, Ne, Ar, Kr, or Xe atoms are measured, and the cross sections for transition of hydrogen atoms to the 2s, 2p, or 3p states are determined. In the energy range studied the cross sections $\sigma(2p)$ and $\sigma(2s)$ are of the order of 10^{-17} cm^2, and $\sigma(2p) > \sigma(2s)$; the cross section $\sigma(3p)$ is of the order of 10^{-18} cm^2. Cross sections $\sigma(2p)$ and $\sigma(3p)$ for He and $\sigma(2s)$ and $\sigma(2p)$ for Ne monotonically decrease with increase of energy. The $\sigma(2p)$ curves for Ar, Kr, and Xe and the $\sigma(3p)$ curve for Kr have two maxima. The cross sections for the H(1s) + $He(1s^2) \rightarrow H(2p,3p) + He(1s^2)$ processes calculated in the first Born approximation decrease with increase of energy in agreement with the experiments. (auth)

39336 EXOTHERMAL CAPTURE PROCESSES WITH IONIZATION PRODUCED IN COLLISIONS BETWEEN He^{2+} IONS AND INERT GAS ATOMS. Latypov, Z. Z.; Flaks, I. P.; Shaporenko, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 57: 50–8(July 1969). (In Russian).

The cross sections σ_{0n} for formation of Ne^{n+}, Ar^{n+}, Kr^{n+}, or Xe^{n+} ions (n = 1, 2, 3) in collisions between doubly charged He^{2+} ions and the respective atoms are measured at energies $0.1 \leq T \leq 8$ keV. An analysis of the dependence of the components of the cross section σ_{0n} on the collision energy T shows that the appearance of peaks in the $\sigma_{0n}(T)$ curves in the case of formation of Ar^{2+}, Kr^{2+}, Xe^{2+}, or Xe^{3+} ions is due to exothermal capture processes concomitant with ionization. The correlation observed between the cross sections σ_{01} and σ_{02} for Ar, Kr, or Xe indicated that exothermal capture with ionization may not only occur directly but also via intermediate competing processes. The magnitudes of the cross sections for exothermal capture with ionization are estimated. (auth)

39337 STREAMER CHAMBER INVESTIGATION OF ELECTRON COLLISION PROCESSES IN NOBLE GASES. Davidenko, V. A.; Dolgoshein, B. A.; Somov, S. W.; Starosel'tsev, V. N. (Moscow Engineering-Physics Inst.). Zh. Eksp. Teor. Fiz., 57: 84–91(July 1969). (In Russian).

Electron thermalization on the track of an ionizing particle in noble gases and the effect of a molecular impurity on thermalization and thermal diffusion of electrons are considered. The cross section for electron attachment to H_2O molecules in the thermal region is determined and is $\sigma_{ap} = (7.5 \pm 0.6) \times 10^{-21}$ cm^2. (auth)

Atomic Theory

39338 APPROXIMATE TREATMENT OF EXCHANGE SYMMETRY IN SECOND-ORDER INTERACTION ENERGIES. Sanders, William A. (Catholic Univ. of America, Washington, D. C.). J. Chem. Phys., 51: 491–5(July 15, 1969).

The second-order energy expression from Hirschfelder–Silbey perturbation theory is rewritten in a form that facilitates a comparison with the conventional Rayleigh–Schrödinger theory. It is shown that the approximate procedure used by McQuarrie and Hirschfelder to evaluate the second-order energy for the $1s\sigma_g$ and $2p\sigma_g$ states of H_2^+ is equivalent to approximating the first-order Rayleigh–Schrödinger function by a symmetry-projected combination of unsymmetric polarization functions. The addition of a correction term to the values calculated by McQuarrie and Hirschfelder leads to substantial improvement of their results. (auth)

39339 ORBITAL APPROXIMATION TO SPATIAL EIGENFUNCTIONS OF THE MANY-ELECTRON HAMILTONIAN. Hameed, Sultan (Yeshiva Univ., New York); Hui, Shirley Seung; Musher, Jeremy I.; Schulman, Jerome M. J. Chem. Phys., 51: 502–8(July 15, 1969).

A new procedure is developed for calculating the best wave function for an N-electron atom in terms of N one-electron orbitals that are eigenfunctions of l^2, l_z, and s_z. This is a special case of a method for calculating the best wave function in terms of N orbitals unrestricted in angular momentum but restricted in spin component and is thus a partial generalization of Löwdin's EHF method. Approximate spatial eigenfunctions of H are calculated using the function $\Phi^{[\alpha,\lambda]} = D^{[\alpha]}_{\lambda\lambda} \sum_{i=1}^{k} \delta_i P_i \phi$, where ϕ is a product of N spatial orbitals and where the P_i are the k permutations out of which k linearly independent projections onto the Young tableau $[\alpha,\lambda]$ can be obtained. The method gives an improvement to each of Goddard's GI solutions in such a way that they all give the same energy when fully minimized, while only involving k–1 additional parameters. For Li atom there is only one additional parameter and calculations are performed using Goddard's GI and GF orbitals, obtaining small improvements in the energy. An energy of –7.4477076 a.u. is obtained. (auth)

39340 HELLMANN–FEYNMAN THEOREM FOR MULTICONFIGURATION SELF-CONSISTENT FIELD THEORY AND CORRELATION ENERGY. Tuan, Debbie Fu-tai (Kent State Univ., Ohio). J. Chem. Phys., 51: 607–11(July 15, 1969).

The Hellmann–Feynman theorem for the multiconfiguration self-consistent field (MC SCF) theory is derived. This theorem is general enough to be applied to both open- and closed-shell systems. In conjunction of this result with Sinanoğlu's many-electron theory of atoms and molecules using the multiconfiguration general restricted Hartree–Fock (GRHF) method, an expression for the change of correlation energies is obtained. It is shown that the correlation energies should be nearly constant with respect to the change of any one-electron parameter, which is independent of symmetry and exclusion effects, of the zeroth-order Hamiltonian. This result justifies the following: (1) The dynamical correlation energies of isoelectronic atomic systems are nearly constant. (2) The potential-energy surface of a molecule determined from the GRHF approximation should be parallel to the actual potential-energy surface. (auth)

39341 A GENERAL SCF FORMALISM. Huzinaga, Sigeru (Univ. of Alberta, Edmonton). Progr. Theor. Phys. (Kyoto), 41: 307–12(Feb. 1969).

A general formalism is developed that includes the multiconfiguration self-consistent-field theory of Hinze and Roothaan as a special case. One can now lift the limitation that the occupation numbers of any given electron shell must have even differences. (auth)

39342 CORRELATION EFFECTS IN ATOMS AND MOLECULES. Lefebvre, R.; Moser, C. (eds.). Advances in Chemical Physics, Volume XIV. London, Interscience Publishers, 1969. 545p. 189s.

The following topics are discussed: atomic Bethe–Goldstone equations; use of cluster expansion and technique of diagrams in calculations of correlation effects; effective operators for configurations of equivalent electrons; applications of many-body diagram techniques in atomic physics; Hartree–Fock method in multiconfiguration approximation; application of extended method of calculation to atomic electrons; correlation energy of a non-uniform electron gas; electron correlation in atoms and molecules; aspects of the correlation problem and possible extensions of the independent-particle model; correlation effects in diatomic molecules obtained from configuration interaction using Hartree–Fock orbital — effects on energy and mono-electronic operators; linked-diagram treatment of configuration interaction in open-shell atoms; and field-theoretic form of perturbation theory for many-electron atoms — abstract theory, atomic systems. (UK)

39343 CALCULATION OF THE ELECTRON SHELLS OF AN ATOM BY THE QUANTUM FIELD-THEORY METHOD. Evdokimov, V. M. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 439–43(Dec. 1968).

Translated from Opt. Spektrosk., 25: 781–90(Dec. 1968).

By means of the quantum field-theory method, a system of successive approximation in the solution of atomic problems has been established within the framework of the one-particle approximation. This system is unambiguously associated with a summation of Feynmann diagrams that make a contribution of a definite order of smallness. The small parameter defining this approximation is, for heavy atoms, the familiar shrinkage parameter. It has been established that this process of successive approximation has the

same significance as the self-consistency process in the Hartree–Fock method, the error being evaluated at each stage of self-consistency. (auth)

39344 APPLICATION OF WAVES AND PARTICLES TO THE STUDY OF MATTER. Stiller, Hans (Kernforschungsanlage, Juelich, Ger.). pp 121-40 of Atome, Kerne, Elementarteilchen. Suessmann, Georg; Fiebiger, Nikolaus (eds.). Frankfurt am Main, Umschau Verlag, 1968. (In German).

The application of waves and particles to the establishment of the arrangement of atoms, the motion of atoms, and the space-time behavior of atoms is described. (J.S.R.)

39345 PHYSICS OF ATOMIC SHELLS. Pauly, Hans (Univ., Bonn). pp 25-43 of Atome, Kerne, Elementarteilchen. Suessmann, Georg; Fiebiger, Nikolaus (eds.). Frankfurt am Main, Umschau Verlag, 1968. (In German).

The Bohr–Sommerfeld model of the atomic shell is described and the results of quantum mechanics are summarized. The Pauli principle and the shell structure of the elements are discussed. The interaction of the atomic shell with external fields and the interaction of atoms with each other are considered. Experimental studies of the atomic shell are described. (J.S.R.)

Cosmic Radiation

Refer also to abstracts 39153, 39166, 39179, 39225, 39241, 39595–39597, 39604, and 39619.

39346 (N-69-24049) THE CORRELATION OF SOLAR MICROWAVE AND SOFT X-RAY RADIATION. PART I. THE SOLAR CYCLE AND SLOWLY VARYING COMPONENTS. Progress Report. Wende, Charles D. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Mar. 1969. Contracts NAS5-9076; JPL-951563; Nonr-1509(06). 43p. (NASA-CR-100719). CFSTI.

Thesis.

The solar-cycle variation and the quiet-Sun component are analyzed. The integral solar x-ray flux between 2 to 12 Å was measured by the spacecrafts Injun 1, Injun 3, Explorer 33, and Explorer 35. The integral flux between 2 to 9 Å was observed by the Mariner V spacecraft. The data from Injuns 1 and 3 and Explorers 33 and 35, averaged in monthly intervals, show a long-term variation in activity of at least a factor of five between 1961 and 1969. A slowly varying component that tracks the 10-cm radio flux is observed in the x-ray flux. This x-ray-flux variation, about a factor of ten, is correlated with the appearance of major active regions on the solar disc. This slowly varying component is shown to correlate well with radio fluxes at frequencies greater than about 1 GHz and less well with radio fluxes at lower frequencies. The x-ray spectrum, obtained by comparing the 2 to 9 Å flux with the 2 to 12 Å flux, hardens during periods of high solar activity. (auth) (STAR)

39347 (N-69-24050) THE CORRELATION OF SOLAR MICROWAVE AND SOFT X-RAY RADIATION. PART 2. THE BURST COMPONENT. Progress Report. Wende, Charles D. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Mar. 1969. Contracts NAS5-9076; JPL-951563; Nonr-1509(06). 57p. (NASA-CR-100730). CFSTI.

Thesis.

The histories of solar flares observed at 2 cm and observed at x-ray wavelengths with Mariner V (2 to 9 Å) and Explorers 33 and 35 (2 to 12 Å) show that post-burst increase and gradual rise-and-fall events are concurrent microwave and soft x-ray phenomena. The correlation between the x-ray flux and the radio flux is high but nonlinear. The character of the correlation is consistent with a thermal flare theory in which the volume emissivity at x-ray wavelengths is of the spectral form $(dE/d\nu) \approx \exp(-h\nu/kT)$ and the radio flux is from the same region which is optically thick with a temperature T. The correlation yields the peak flare temperature T_p, and the flare solid angle in terms of the fractional increase in temperature relative to the peak temperature. (auth) (STAR)

39348 (N-69-24170) A SEARCH FOR GAMMA-RAYS FROM THE CRAB NEBULA USING A DIGITIZED SPARK CHAMBER. Kniffen, Donald Avery (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1969. 73p. (NASA-TR-R-308). CFSTI.

Gamma-ray astronomy provides an opportunity to obtain information directly related to the physical processes taking place within celestial objects; processes that may also give rise to the energetic charged-particle cosmic rays. The detection of celestial gamma-ray point sources may shed some light on the origin of cosmic rays. One of the most likely sources, the Crab nebula, was chosen for investigation in this experiment. The detector developed for this investigation is a digitized spark chamber, mounted in an oriented gondola and flown by balloon above all but a small amount of the Earth's atmosphere. The detector is triggered by a scintillation counter Cerenkov detector charged particle telescope, in the event that no charged particle has passed through the anticoincidence scintillator that surrounds the entire detector. Analysis of the data consists of examining each event recorded during the flight for the pair-production events. The celestial arrival direction of each gamma ray is estimated by the bisector of the pair. The construction of the chamber with many thin plates alternated with the spark modules allows a determination of the gamma ray energy in the 30- to 250-MeV energy range by the multiple scattering technique. (auth)

39349 DIRECTIONS OF APPROACH OF COSMIC RAYS FOR HIGH-LATITUDE STATIONS. Gall, Ruth; Jimenez, J.; Orozco, A. (Univ. Nacional Autonoma de Mexico, Mexico City). J. Geophys. Res., 74: 3529-40(July 1, 1969).

Approach directions of cosmic rays for quiet times were computed for high-latitude stations using a model magnetosphere. This paper describes results obtained for four typical stations: Kiruna, Byrd, Churchill, and Resolute. Computations included approach directions for vertical incidence, cones for wide ranges of angles of incidence, regions of penetration at the magnetopause for arrival of cosmic rays, all for noon and midnight, and hourly scanning rates. Directions of approach, particularly for medium and low rigidity, present a daily variation, indicating that they do not corotate with the station and that the previous computations based on an internal field model do not accurately present the directions of viewing. A station normally views more easterly directions at noon than at night; this effect is inverted for some very high-latitude stations, which, moreover, view at night directions that form small angles with the equator. Cones for low-rigidity particles are found to be narrow. A collimated beam of limited-rigidity range of cosmic rays coming from the interplanetary medium widens and approaches the station under all pitch angles. The importance of the results for detection of low-rigidity galactic cosmic rays and of solar corpuscular events by means of balloons is discussed. (auth)

39350 VARIATION WITH A PERIOD OF TWO SOLAR CYCLES IN THE COSMIC-RAY DIURNAL ANISOTROPY AND THE SUPERPOSED VARIATIONS CORRELATED WITH MAGNETIC ACTIVITY. Forbush, Scott E. (Carnegie Institution of Washington, D. C.). J. Geophys. Res., 74: 3451-68(July 1, 1969).

Annual means of the diurnal anisotropy from 1937 to 1967 are shown to result from the addition of two distinct diurnal components. One component, with maximum in the asymptotic direction 128° east of the Sun, contains a well-determined wave, W, with a period of two solar cycles. W passes through zero in 1958 when the Sun's poloidal field reversed. The remaining component with W eliminated, has its maximum in the asymptotic direction 90° east of the Sun. Annual means of this component, with maximum at 18.0 hours local asymptotic time, are well correlated ($r = +0.75$) with magnetic activity and determine a solar cycle variation with minimum near sunspot minimum and amplitude about two-thirds that of W. These results derive from a statistical investigation of the variability of annual means of the diurnal variation from ion-chamber data at Cheltenham–Fredericksburg, Huancayo, and Christchurch. The absolute, or total, diurnal anisotropy and the atmospheric diurnal temperature effect are in reasonable agreement with those derived independently through a comparison between the diurnal anisotropy from ion-chamber data and from Simpson's 1953–1966, IGY neutron monitor data at Huancayo. (auth)

39351 ON COMPARISON OF THEORETICAL AND EXPERIMENTAL VALUES OF THE s PARAMETER FOR EXTENSIVE AIR SHOWERS. Kalmykov, N. N.; Sushchenko, V. V. (Moscow State Univ.). Yadern. Fiz., 9: 1204-9(June 1969). (In Russian).

Space distribution of electrons in an extensive air shower at sea level at the primary energies 10^7 to 10^5 GeV is considered in the range of distances from 2 up to 300 m. The space distribution functions are obtained both with and without account of the effect of transversal momenta that the secondary particles get in the process of nuclear interaction. The obtained distributions are compared with the Nishimura–Kamata standard function corresponding to the mean value of the s parameter for the extensive shower, at various distances from the shower axis. (auth)

39352 REMOVAL OF METEOROLOGICAL EFFECTS FROM MESON-TELESCOPE DATA. Briggs, R. M.; Hicks, R. B.; Standil, S. (Univ. of Manitoba, Winnipeg). Can. J. Phys., 47: 1429-33(July 15, 1969).

Hourly data from a meson mega-telescope have been correlated with the local barometric pressure, the ground-level temperature, and with intensity variations as observed by a distant neutron

monitor. Two techniques are considered, viz., a vector least-squares analysis and an hourly regression analysis, the latter being suggested as a practical method whereby stations without radiosonde information may correct their hourly meson data for changing meteorological conditions. (auth) (Canada)

39353 ATMOSPHERIC MUONS AND NEUTRINOS. Koshiba, Masatoshi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 41: 832-5(Mar. 1969).

A simple and direct relation between the energy spectra of atmospheric mesons and neutrinos is obtained. This functional relation allows the neutrino spectra to be estimated directly from the observed muon spectra without first having to solve the atmospheric nuclear cascade, provided the relative contributions of π and K are known. (L.B.S.)

39354 ARE COSMIC ELECTRONS ANISOTROPIC? Earl, James A.; Lenchek, Allen M. (Univ. of Maryland, College Park). Astrophys. J., 157: 87-101(July 1969).

Because the rate of energy loss due to synchrotron radiation depends upon pitch angle, the flux of relativistic cosmic-ray electrons tends to become strongly anisotropic as the electrons propagate in the galactic magnetic field. The effective exposure time of electrons to the synchrotron effect, which determines the magnitude of the anisotropy, is set by energy loss due to the inverse Compton effect, by leakage from the Galaxy, or scattering by interstellar magnetic irregularities. Since the times corresponding to these effects depend upon electron energy in different ways, the electron anisotropy spectrum, i.e., the functional dependence of anisotropy upon electron energy, is very sensitive to details of cosmic-ray propagation and to conditions in interstellar space. This implies that observations of electron anisotropies will provide significant information, particularly in exploring the possibility that self-generated waves are an important factor governing the propagation of cosmic rays. Explicit expressions for anisotropy spectra to be expected in several likely configurations are calculated as equilibrium solutions of an equation of pitch-angle diffusion. Estimated anisotropies, obtained with the aid of the theory, are, under certain conditions, large enough to be readily observable. The obscuring effect of interplanetary magnetic fields is estimated and found to be of minor importance for electron energies greater than 90 GeV. (auth)

39355 STABILITY OF THE ^{7}Be IN GALACTIC COSMIC RADIATION. Yiou, F. (Centre National de la Recherche Scientifique, Orsay, France); Guchan-Beck, F. J. Phys. (Paris), 30: 401-5(May-June 1969). (In French).

At rest ^{7}Be decays to ^{7}Li through electron capture with a 53.6-day half life. Hence, the lifetime of this isotope is dependent on the electron density about the nucleus. It has been suggested that, in galactic cosmic rays, ^{7}Be would be very long-lived. The comparison of recent cross-section measurements for the production of Li, Be, and B by spallation of ^{12}C and ^{16}O by high-energy protons with the elemental ratios Be/Li and Be/B found in cosmic rays lead to the conclusion that ^{7}Be is stable in this radiation. Cosmic-ray beryllium would, hence, be essentially ^{7}Be. (auth)

Direct Energy Conversion

Refer also to abstracts 38068 and 39499.

39356 MAGNETIC SYSTEMS WITH STEEL FOR MHD-GENERATORS. Bul, O. B. Izv. Vyssh. Ucheb. Zaved., Elektromekh., No. 12, 1333-40(1967). (In Russian).

Design and construction of a magnetic system used in MHD generators are discussed. Calculations on annular magnetic systems are presented. The results of calculations are compared with the basic parameters by rectilinear magnetic systems designed for the identical MHD generator. (R.V.J.)

39357 MAGNETOHYDRODYNAMIC ENERGY CONVERSION APPARATUS. (to Compagnie Electro Mecanique). British Patent 1,158,862. July 23, 1969. Priority date July 23, 1965, France.

An MHD generator using several flow paths for a conductive liquid is described. Each flow path is in the form of a closed loop. (M.O.W.)

39358 EXPERIMENTAL INVESTIGATIONS OF THE OPERATIONAL BEHAVIOR OF AN INDUCTIVE MHD CONVERTER. Schulz, Tilo; Ulber, Meinhard. Wiss. Ber. AEG-Telefunken, 41: 168-77(1968). (In German).

Following a description of the test assembly and the measuring equipment of the converter, measurements without a working medium are dealt with. The no-load characteristic, no-load losses, and the asymmetries of the three-phase system are described in detail. Measurements of the field distribution in the air gap on polyphase and dc excitation and, finally, the simulation of a short-circuit test with a copper bar are reported. For the experiments with a working medium, a NaK alloy is used. By means of measurements of pressure decrease and flow rate in the MHD duct, as well as of the electrical ratings, current locale curves, power flow diagrams, and efficiencies were determined on a stable network for generator, pump, and braking operation. The highest useful electrical power obtained this way was 3 kW at an overall efficiency of 15%, or 30% when the duct friction losses are not taken into consideration. Moreover, the converter was examined as a self-excited generator and with variable frequency. The experiments show that the inductive MHD converter behaves in principle as a conventional asynchronous machine. Differences are caused above all by the finite linear field, the flow-profile influences, the nonexistent rotor spread, and the high stator current reactance ($\approx$1.5 Ω) which exhibits the same degree of magnitude as the main reactance. (auth)

39359 GENERATION OF PRESSURE WAVES IN FISSIONING GASES. Podney, W. N.; Smith, Harold P. Jr.; Oppenheim, A. K. (Univ. of California, Berkeley). Ind. Chim. Belge, 32: Special No., (Vol. 2), 24-8(1967).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.2).

The theory of the generation of pressure waves in closed tubes containing multiplying or non-multiplying fissionable gases is reviewed. Two means of producing pressure waves are considered: (1) an external neutron pulse irradiating an initial segment of a tube containing a non-multiplying, fissile gas and (2) an internal neutron pulse arising from neutron multiplication in a fissionable gas, surrounded by a neutron reflector, that is compressed to a supercritical state by a shock wave. In case (1) the problem is formulated in the characteristic form of the equations of motion describing one-dimensional, non-steady, inviscid motion of a perfect gas, and in terms of a model which assumes that the irradiated gas expands in bulk. Close agreement of the numerical solutions obtained on the basis of this bulk expansion model and the method of characteristics implies that results obtained by including real gas effects in the bulk expansion model are reasonable. Application of this model to case (2) shows that a well-defined delay time exists between shock-wave compression of the gas and its subsequent expansion caused by fission energy released in the gas. (auth)

39360 AN INFLUENCE OF WALL CONDUCTION ON THE PLASMA CONDUCTIVITY IN SEGMENTED-ELECTRODE MHD-GENERATOR DUCT. Sakaguchi, Tadao; Noguchi, Toru (Kyoto Univ.). Tech. Rep. Eng. Res. Inst., Kyoto Univ., No. 146, 1-11 (Mar. 1969).

In a segmented-electrode duct having poor insulation, the effective conductivity of the working gas is reduced in the magnetic field. This conductivity reduction is considered due to the Hall current flowing in the wall–plasma loop. The reduction factor of plasma conductivity is given by the leakage conductivity of the wall and the Hall parameter. The results show conductivities will be very low, under the conditions of high Hall parameter and relatively small conductivity ratio. The experimental results obtained with simulated Faraday-type ducts agree with the calculated values. In the case of MHD power generation, using high-temperature gas-cooled nuclear reactor as a heat source, it may be possible to effect high plasma conductivity by perfect insulation of electrodes and preionization prior to magnetically induced nonequilibrium ionization. (auth)

Fluid Physics

39361 MAGNETOHYDRODYNAMIC DISTURBANCES IN A SEMI-INFINITE FLUID OF FINITE ELECTRICAL CONDUCTIVITY. 1. el Mohandis, M. G. S. (Ain-Shams Univ., Cairo). Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur., 103: 429-50(May-June 1969).

The problem of MHD disturbances due to the sudden introduction of a magnetic dipole in an infinite fluid of finite electrical conductivity in which a uniform field is prevailing was discussed previously. In the present work, a magnetic dipole is suddenly introduced to act as a source of disturbance in a semiinfinite fluid, in which a uniform field H_0 is prevailing, with the axis of the dipole placed parallel to an insulating plane boundary. The direction of H_0, the excited field is taken to be perpendicular to the plane boundary and to the dipole axis. Mathematical solutions for the arising MHD disturbances at the plane interface between the insulator and the fluid are given as well as in the insulator itself. (auth)

39362 THE MAGNETOHYDRODYNAMIC COUETTE FLOW BETWEEN TWO PARALLEL WALLS WITH VARIABLE SUCTION.

Messiha, S. A. S. Atti Acad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur., 103: 463-73(May-June 1969).

The problem of two-dimensional viscous incompressible fluid flow between two infinite plane porous walls is considered when the fluid is electrically conducting with an imposed uniform magnetic field perpendicular to the walls. The magnetic Reynolds number is assumed to be very small so that the induced magnetic field is neglected. One wall is assumed to be fixed and the motion of the other wall, as well as the suction velocity, varies periodically with time about a non-zero constant mean. Expressions for the velocity field and the skin-friction at the walls are obtained in a non-dimensional form in terms of a magnetic parameter $S = (1/2)\,[1 + (4M^2/R^2)]^{1/2}$ where M is the Hartmann number and R is the suction Reynolds number. It is found that the amplitude of skin-friction fluctuations at the fixed wall decreases while that of the moving wall increases with increasing S. Both the phase lag of the skin-friction fluctuations at the fixed wall and the phase lead at the moving wall decreases with increasing S for all values of the frequency parameter ω and the suction parameter A. (auth)

39363 THE VISCOUS FLOW OF CONDUCTING FLUIDS PAST THIN AIRFOILS, FOR THE SPECIAL CASE $\sigma\mu\nu = 1$. Marcov, N. (Univ., Bucharest). Stud. Cercet. Mat., 21: 759-71(1969). (In Rumanian).

The steady, two-dimensional flow of viscous, incompressible, conducting fluids past thin airfoils in the presence of a magnetic field, is considered. The undisturbed flow and applied magnetic field are not parallel. The magnetic Prandtl number $\sigma\mu\nu$ where σ is the fluid electrical conductivity, μ is the magnetic permeability and ν is the coefficient of viscosity, is supposed equal to unit. Using Oseen-type approximation, the general expressions are obtained for the velocity and magnetic field. Thus, the problem may be formulated as a singular integral equation. As an example of application, the flows at large or small Reynolds numbers past a finite flat plate, were considered. (auth)

Geophysics (Upper Atmosphere)

Refer also to abstracts 38303, 38342, 39221, 39224, 39242, and 39626.

39364 (N-69-23536) SOME PECULIARITIES OF PLASMA MOTIONS IN THE EARTH'S MAGNETOSPHERE. Samokhin, M. V. Translated from Geomagn. Aeron., 9: 16-22(1969). 7p. (NASA-CR-100690). CFSTI.

The motion of matter inside the Earth's magnetosphere is investigated. It is shown that at flow with free boundary inside the magnetosphere, there sets in an eddy current, whereupon the matter velocity changes sign as it passes through the frontal point. As an example, the structure of the vortex flow is investigated in the incompressible fluid with the forbidden zone having the shape of a cylinder or a sphere. Investigated also is the quasi-hydrodynamic flow in the vicinity of the frontal point. (auth) (STAR)

39365 (N-69-23630) TRANSIENT ELECTROMAGNETIC INTERACTION OF THE MOON WITH THE SOLAR WIND. Schwartz, Kenneth; Schubert, Gerald (American Nucleonics Corp., Glendale, Calif.). 1968. Contract NAS2-5153. 12p. (NASA-CR-73314). CFSTI.

The response of a homogeneous conducting moon to variations and irregularities in the interplanetary magnetic field is determined. The significant lunar response is forced by fluctuations in the motional electric field. In the limit of a highly conducting plasma surrounding the moon and for length scales of the interplanetary magnetic field irregularities much larger than the moon's radius, the magnetic field fluctuations in the lunar interior are the sum of variations in the driving interplanetary magnetic field plus field fluctuations driven by the motional electric field. The magnitude of the motionally induced time-varying magnetic field inside the moon is proportional to the product of the magnitude of the interplanetary magnetic field fluctuations and the lunar magnetic Reynolds number. This induced field is toroidal about an axis in the direction of the forcing motional electric field. The motionally induced magnetic field in the plasma is also toroidal and is confined to a thin layer near the lunar surface. The electric field is everywhere equal to the forcing motional electric field. (auth) (STAR)

39366 SPORADIC E LAYER OVER TIRUPATI. Rao, T. V. Krishna; Murthy, M. J. Kesava (Sri Venkateswara Univ., Tirupati, India). Curr. Sci. (India), 38: 336(July 20, 1969).

Tirupati is a low-latitude station (latitude 13° 40′ N, longitude 79° 27′ E., geomagnetic latitude 3° 45′ N.) situated in Andhra Pradesh. Observations made during December 1968 to April 1969 on the sporadic-E layer are presented. (M.O.W.)

39367 IONOSPHERIC GAS DYNAMICS OF SATELLITES AND DIAGNOSTIC PROBES. Liu, V. C. (Univ. of Michigan, Ann Arbor). Space Sci. Rev., 9: 423-90(June 1969).

The gas dynamics of interactions of a tenuous ionosphere with moving satellites and probes that have bearings on the diagnostics of the ionosphere are discussed. Emphasis is on the cases where the body is moving at mesothermal speeds, namely intermediate between the thermal speeds of ions and electrons of the ambient ionosphere. Methods of collision-free plasma kinetics with self-consistent field are used. The development of the topics for discussion starts with stationary Langmuir probe which entails the basic mechanism of body–plasma interaction that becomes further intricated as the body moves at a higher and higher speed. Applications of the theory of plasma interaction to meteors that move in the ionosphere are also presented. (auth)

39368 PREDAWN ENHANCEMENT IN f_0F_2 AT JOHANNESBURG. Torr, M. R. (National Inst. for Telecommunications Research, Johannesburg). Nature (London), 223: 282-3(July 19, 1969).

It has been shown that during winter, as the Sun rises in the conjugate hemisphere, electron temperatures in the local unlit ionosphere rise at altitudes above about 300 km. Plots of f_0F2 are shown for local times 00 to 09 at Johannesburg for 3 days in June 1964, which indicate a definite predawn enhancement with magnetic conjugate point (MCP) sunrise at ~300 km. The enhancement reached a peak and then declined to its earlier level for a period of 1 to 2 hr before the local sunrise increase. The initial enhancement appears to be caused by MCP photoelectrons; it does not occur in summer. Explanation of the subsequent short decrease, however, is not obvious. It has been suggested that the enhancement is due to direct excitation of 6,300Å airglow by the photoelectron flux, since heating of the ambient electrons by MCP photoelectrons could not result in the observed enhancement. A detailed mechanism is offered. (UK)

39369 THE EFFECT OF THE LATITUDINAL VARIATION OF THE TERRESTRIAL MAGNETIC FIELD STRENGTH ON ION CYCLOTRON WHISTLERS. Jones, Dyfrig (Cavendish Lab., Cambridge, Eng.). J. Atmos. Terrest. Phys., 31: 971-81(July 1969).

The propagation of a low-frequency electromagnetic wave in a cold multicomponent plasma in which collisions between electrons, ions, and neutral particles can occur, is discussed. The wave frequencies are of the order of the ion gyrofrequencies. When the angle θ between the wave normal and the magnetic field exceeds a critical value θ_c, then the sense of rotation of the electric and magnetic field vectors of the wave can suffer reversal. This is discussed for a model night-time ionosphere, and it is shown that the value of θ_c, and the height at which reversal occurs, depend on frequency. An ion cyclotron whistler has three frequencies associated with it, namely the ion gyrofrequency at the satellite, the crossover frequency at the satellite, and the cutoff frequency. The cutoff frequency is the greatest frequency that has suffered polarization reversal in traversing the lower ionosphere. The main purpose of this paper is to determine the effect of the latitudinal variation of the terrestrial magnetic field on the cutoff frequency of proton whistlers. It is assumed that the wave normal is refracted to become vertical on entering the lower ionospheres, so that θ is related to magnetic latitude ϕ. Also considered is the effect of the magnetic field strength variation on the high-latitude cutoff of proton whistlers. (auth) (UK)

39370 THE EFFECTS OF IONS ON THE PROPAGATION OF elf AND vlf WAVES IN THE LOWER IONOSPHERE. Thomas, L. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 31: 991-1002(July 1969).

The differential equations governing the propagation of electromagnetic waves in the presence of electrons, positive ions, and negative ions are formulated. These equations are integrated numerically to examine the effects of heavy ions on the propagation of waves of frequency 10 Hz to 30 kHz incident at angles of 30° and 80° on the lower ionosphere. It is found that for an ionospheric model representative of quiet conditions, ions have very little influence on reflection coefficients. Significant effects are, however, found for a model representing a disturbed ionosphere, especially at the higher frequencies. An examination of the standing wave-field patterns set up in the ionosphere helps in the interpretation of these effects. (auth) (UK)

39371 NEUTRAL WINDS AND UNIVERSAL-TIME CONTROL OF THE POLAR F REGION. Duncan, R. A. (CSIRO, Camden, Australia). J. Atmos. Terrest. Phys., 31: 1003-9(July 1969).

A re-examination of the diurnal variation of F-region electron density over the Antarctic gives no support to the suggestion of King and Kohl (1967 and 1968) that these variations arise from diurnally rotating neutral winds. (auth) (UK)

39372 AN EXPLANATION OF THE MAGNETIC DECLINATION EFFECT IN THE IONOSPHERIC F2 LAYER. Kohl, H. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.); King, J. W.; Eccles, D. J. Atmos. Terrest. Phys., 31: 1011-16(July 1969).

It is shown that the different diurnal variations of F2-layer critical frequency which are observed at pairs of stations having similar geographic latitudes and magnetic inclinations, but different declinations, may be caused by neutral air winds. These winds produce, above any station, vertical ionospheric drifts having a diurnal variation with a phase and amplitude which depend on the local magnetic declination. (auth) (UK)

39373 A FEATURE OF THE POLAR F REGION. Bratteng, O. M.; Frihagen, J. (Auroral Observatory, Tromsoe, Norway). J. Atmos. Terrest. Phys., 31: 1017-20(July 1969).

Attention is given to the anomalous enhancement of ionospheric electron content at about 78°N geographic latitude at about 09.00 local mean time, i.e., close to noon local geomagnetic time. Contours of constant electron content versus geographic latitude and local mean time are shown. The electron content was measured by the differential-frequency Faraday rotation method, using the 40- and 41-MHz beacons on satellite BE-B. The observations were made at Isfjord radio on Spitsbergen (78°N, 14°E). (UK)

39374 AIRBORNE OBSERVATION OF THE MIDDAY AURORA. Buchau, Jurgen (Air Force Cambridge Research Labs., Bedford, Mass.); Whalen, James A.; Akasofu, S.-I. J. Atmos. Terrest. Phys., 31: 1021-6(July 1969).

On December 13, 1967, a KC-135 aircraft equipped with an ionospheric sounder, a photometer, and an all-sky camera made a flight into the midday portion of the auroral oval and the polar cap region between Greenland and Spitzbergen. Under the quiet magnetic conditions occurring on that day, the midday aurora consisted of a single arc which lay within the expected region of the oval. The aurora was absent inside the oval. There was a strong correlation between auroral E_s and visible overhead aurora. Near the end of the flight, when sunrise prevented optical observations of the aurora, the observed occurrence of E_s was used to infer the width of the auroral oval. (auth) (UK)

39375 THE EFFECT OF A TOTAL SOLAR ECLIPSE ON THE PHASE OF LONG-PATH vlf TRANSMISSIONS. Hoy, R. D. (Australian National Univ., Canberra). J. Atmos. Terrest. Phys., 31: 1027-8(July 1969).

The effects of the total solar eclipse of September 22, 1968 on vlf transmissions (16 kHz) from GBR Rugby, as received at Canberra, were studied. A phase change was found to be associated with the eclipse, corresponding to an increased time of propagation over the path of 3.3 μsec. (auth) (UK)

39376 MEASUREMENTS OF PRECIPITATED 1 TO 20-keV PROTONS AND ELECTRONS DURING A BREAKUP AURORA. Bernstein, W.; Inouye, G. T.; Sanders, N. L.; Wax, R. L. (TRW Systems, Redondo Beach, Calif.). J. Geophys. Res., 74: 3601-8 (July 1, 1969).

Measurements of precipitating low-energy (1 to 20 keV) protons and electrons during a breakup aurora are described. The observed proton fluxes were as high as 10^8 cm^{-2} sec^{-1} keV^{-1} ster^{-1} with a differential energy spectrum of the form $E^{-3.2}_{(keV)}$; the electron fluxes were ~10^9 cm^{-2} sec^{-1} keV^{-1} ster^{-1} with a spectral peak in the the 2 to 4-keV region. During the flight, the rocket passed through the poleward boundary of the auroral form. One interpretation of the data suggests that the proton and >2.5-keV electron precipitation boundaries coincided to within a distance of <1 km; the lower-energy electron boundary extended several kilometers poleward of the proton boundary. Evidence for nonisotropic proton fluxes is presented. (auth)

39377 LOW-ALTITUDE TRAPPED PROTONS DURING SOLAR MINIMUM PERIOD, 1962-1966. Heckman, Harry H.; (Univ. of California, Berkeley); Nakano, George H. J. Geophys. Res., 74: 3575-90(July 1, 1969).

Observations of energetic protons in the inner radiation belt have been carried out since September 1962 with emulsion detectors recovered from polar-orbiting low-amplitude satellites. The following experimental results were obtained between November 1962 and June 1966 during the period of minimum solar activity: (a) No detectable changes occurred in the omnidirectional proton flux and energy spectrum above 57 MeV. (b) Measurements of the east-west asymmetry of the proton flux at 132 MeV yield a value of 4.93 ± 0.12 for the exponent n of the power-law relationship between the omnidirectional flux and altitude. This value of n is in agreement with that deduced directly from the omnidirectional flux vs altitude profile. (c) The measured proton flux scale heights are significantly larger than can be accounted for by the Harris and Priester model atmosphere. Apart from effects due to sources other than albedo neutron decay, the data suggest either that errors exist in the model atmosphere, particularly in regards to the density gradient, or that adiabatic particle motion is violated. (auth)

39378 RADIAL DIFFUSION OF STARFISH ELECTRONS. Farley, Thomas A. (Univ. of California, Los Angeles). J. Geophys. Res., 74: 3591-3600(July 1, 1969).

A study of the change in electron intensities in the Starfish electron belt from January 1, 1963, to November 3, 1965, indicates that radial diffusion, both inward and outward from L of 1.40, was a significant loss mechanism for these electrons during this period. For L values of 1.20 and below, the indicated steepening of the pitch-angle distributions during this period has been interpreted as the result of a radial diffusion source for each L shell concentrated near the geomagnetic equator. Since pitch-angle diffusion lifetimes are not well known for $1.20 < L < 1.65$, a definitive radial diffusion coefficient cannot be computed from these data. A maximum reasonable diffusion coefficient (mean square displacement per unit time) computed for this range of L for this period has a minimum at L of 1.31, and a value of 4.4×10^{-5} R_E^2/day at that point. This maximum coefficient, representing an average over a 3-year period, is more than an order of magnitude too small to account for the apparent radial diffusion of natural electrons into this region that took place in September 1966. The results are, however, consistent with population of the inner zone by radial electron diffusion occurring during relatively short periods during which the diffusion coefficient is enhanced by two or three orders of magnitude. (auth)

39379 EXPLORER 12 MAGNETOPAUSE OBSERVATIONS: LARGE-SCALE NONUNIFORM MOTION. Kaufmann, Richard L. (Univ. of New Hampshire, Durham); Konradi, Andrei. (J. Geophys. Res., 74: 3609-27(July 1, 1969).

A number of events have been studied that provide evidence that relatively small portions of the magnetopause occasionally become severely distorted. The largest distortions are generally elongated in the north-south direction, and the magnetosheath magnetic field is usually either nearly parallel or antiparallel to the magnetospheric field. As a result, the distortions do not involve severe bending of any magnetic field lines. The distortion is frequently triggered by a change in the properties of the solar wind. A model involving propagation of a thin discontinuity past the Earth is consistent with the observations. Observationally, the severe distortions are distinct from the small-scale more or less uniform radial excursion of the magnetopause that is seen on a large fraction of all magnetopause crossings. They are also distinct from the expansions and contractions of the entire magnetosphere in response to changing solar wind pressure. (auth)

39380 RADIO FREQUENCY SYNCHROTRON RADIATION FROM INNER-BELT TRAPPED ELECTRONS. Vesecky, John F. (Stanford Univ., Calif.). J. Geophys. Res., 74: 3628-38(July 1, 1969).

Estimates of satellite-observed synchrotron emission are made by applying the appropriate theory to a model of the magnetospheric environment based on satellite and ground-based measurements. Emission from electrons in the inner trapped radiation belt is most intense for ray paths that lie close to the geomagnetic equatorial plane. For a satellite observer at a geocentric distance of 4 R_E the peak synchrotron brightness is about 1.5×10^{-20} w/m^2 Hz ster for frequencies of 3 to 10 MHz, decreasing sharply for frequencies below 1 MHz and falling gradually for frequencies greater than 10 MHz. This peak emission is about a factor of 5 below the cosmic noise from the brightest portion of the sky but a factor of more than 100 above the dimmest portion. Since synchrotron emission is strongly polarized at the source and the cosmic background is not, the detection of synchrotron emission against a stronger but randomly polarized background by means of polarization discrimination techniques is investigated and found to be useful. It is concluded that synchrotron radiation from trapped electrons is strong enough to be observed by a satellite receiver thus providing information regarding geomagnetically trapped electrons. This synchrotron radiation could also be a cause of confusion during satellite radio astronomical measurements in the 1- to 15-MHz frequency range. (auth)

39381 BOW-SHOCK-ASSOCIATED WAVES OBSERVED IN THE FAR-UPSTREAM INTERPLANETARY MEDIUM. Fairfield, D. H. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 74: 3541-53(July 1, 1969).

Fifty orbits of Explorer 34 data were used to study 0.01 to 0.05-Hz transverse waves in the interplanetary medium region between the bow shock and the spacecraft apogee of 34 R_E. It is concluded that the waves are associated with the bow shock since they only occur when projection of the interplanetary field observed at the spacecraft intersects the shock. The waves are observed 18.5% of

the time when a total of 134 days of interplanetary data is considered, but more than 90% of the time when the field has the proper orientation with respect to the bow shock. On the basis of this result it is suggested that these waves with 20 to 100 second periods are a permanent feature of the solar wind–Earth interaction. The transverse component of the waves is typically several gammas in amplitude in 4 to 8 gamma fields. The disturbance vector in the XY plane generally exhibits the same sense of rotation in a coordinate system where the field is oriented along the positive z axis. Attenuation of wave amplitudes with distance from the bow shock is estimated to be only a factor of 2 when the spacecraft is 15 R_E from the bow shock. The absence of waves at particular field orientations, even though the field line intersects the shock, is interpreted as a propagation effect. This observation is the basis for calculations that yield an average velocity in the plasma frame of 2.7 ± 0.4 times the solar wind velocity. Whistler propagation and local generation by two-stream instability are discussed as alternate theoretical explanations for the presence of the waves. It is suggested that the data favor the latter mechanism. (auth)

39382 DAWN–DUSK ASYMMETRIES IN THE OUTER RADIATION ZONE AT MAGNETICALLY QUIET TIMES. McDiarmid, I. B.; Burrows, J. R.; Wilson, Margaret D. (National Research Council of Canada, Ottawa). J. Geophys. Res., 74: 3554–60(July 1, 1969).

The experiment reported here is an attempt to detect effects of a dawn-to-dusk electric field of the type implied by recent models of plasma convection in the magnetosphere. Outer radiation zone electron intensities (E > 35 keV) measured near dawn and dusk are compared as a function of L for three magnetically quiet periods. A requirement of the experiment is to examine the outer-zone steady state and in particular to avoid local time dependent effects of nonadiabatic acceleration processes. For this reason the quiet periods were selected by choosing intervals of a few days each when the outer-zone intensity showed a steady decay. At L values greater than 5.5 higher intensities were observed near dawn than near dusk and the dawn–dusk difference increases with increasing L; at L ~ 7 dawn intensities are approximately 40% higher than dusk intensities. The results are used to place upper limits on the potential drop across the magnetosphere, which are somewhat smaller than implied by plasma convection models. Other possible mechanisms that could account for the observations are also discussed. (auth)

39383 IONOSPHERIC AND MAGNETIC OBSERVATIONS AT 1000 km DURING THE GEOMAGNETIC STORM AND AURORA OF MAY 25–26, 1967. Findlay, J. A. (Goddard Space Flight Center, Greenbelt, Md.); Dyson, P. L.; Brace, L. H.; Zmuda, A. J.; Radford, W. E. J. Geophys. Res., 74: 3705–12 (July 1, 1969).

Measurements of electron temperature and number density and of transverse magnetic disturbances obtained at 100 km before, and after the magnetic storm and aurora of May 25–26, 1967, are compared with visual observations of the aurora, and a degree of correlation is apparent. Throughout the latitudinal region of visual aurora the electron temperature and its latitudinal variations were much greater than are observed under quiet conditions. Temperatures in excess of 6500°K and temperature variations of greater than 500°K within less than 4 km along the satellite path were measured. Temperatures this high suggest a heat source other than auroral electron bombardment. The electron number density was also extremely structured through the region of visual aurora. Horizontal gradients were observed in which the number density changed by greater than 50% in less than 100 meters along the satellite path. The greatest number density measured was ~6.5 × $10^4/cm^3$ (at Λ = 53°). The magnetometer recorded a number of disturbances (as large as 306γ) in the region of unusual concentration and temperature behavior. (auth)

39384 TWO-DIMENSIONAL CHAPMAN–FERRARO PROBLEM WITH NEUTRAL SHEET. 2. THE INTERIOR FIELD. Atkinson, G.; Unti, T. (California Inst. of Tech., Pasadena). J. Geophys. Res., 74: 3713–16(July 1, 1969).

The magnetic field line configuration is presented for the flow of plasma around a two-dimensional dipole in the Chapman–Ferraro approximation, allowing for the formation of a tail and neutral sheet. This is compared with the case without neutral sheet, and some conclusions are made about the distortion of the magnetosphere by the tail. A short discussion of the tail is given, in which it is concluded that if streaming motions are not important in the neutral sheet, then the magnetic field must have a component ~1 γ normal to the neutral sheet, which decreases with distance down the tail. (auth)

39385 PROPAGATION OF ELF WAVES UNDER NORMAL AND NATURALLY DISTURBED CONDITIONS. Field, E. C. (Rand Corp., Santa Monica, Calif.). J. Geophys. Res., 74: 3639–50(July 1, 1969).

This study presents a theoretical analysis of the propagation of electromagnetic waves in the frequency range 30 to 1000 Hz in the Earth–ionosphere waveguide. Full wave methods incorporating the vertical inhomogeneity of the ionosphere are used in conjunction with model ionospheres corresponding to ambient and disturbed (PCA) conditions. For ambient conditions, the character of the assumed ion-density profile below 60 km substantially affects the computed attenuation rates, phase velocities, Joule heating rates, and field strengths for waves at frequencies lower than a few hundred Hz. For example, at a wave frequency of 50 Hz, 30% to 50% of the attenuation is due to losses associated with ion heating. At frequencies of a few hundred Hz or higher the losses, under ambient conditions, are related almost entirely to electron heating. Under moderate PCA conditions the losses are due mainly to ion-heating for the entire ELF frequency range, and the attenuation rates are substantially higher than for undisturbed situations. The ionospheric height ranges which influence the ELF mode structure are quite broad being typically many tens of kilometers in thickness. The influence of the geomagnetic field upon the mode characteristics is substantial in the undisturbed nighttime, slight in the undisturbed daytime, and essentially nil under PCA conditions. (auth)

39386 BALMER ALPHA AND LYMAN BETA IN THE HYDROGEN GEOCORONA. Meier, R. R. (Naval Research Lab., Washington, D. C.). J. Geophys. Res., 74: 3561–74(July 1, 1969).

The spherical Lyman-β radiative transfer problem is solved for several theoretical models of the hydrogen geocorona. Comparisons of the computed intensities with the experimental observations of Lyman β and Balmer α airglows show that the geocoronal Balmer α contribution is superimposed on a uniform background of about 4 R. The 4-R background is probably galactic (or extragalactic) in origin. The column density of hydrogen required to account for the telluric Balmer α component is about 5×10^{13} atoms per cm^2 above 650 km for a 950°K exosphere. (auth)

39387 ION DEPLETION IN THE HIGH-LATITUDE EXOSPHERE: SIMULTANEOUS OGO 2 OBSERVATIONS OF THE LIGHT ION TROUGH AND THE VLF CUTOFF. Taylor, H. A. Jr. (Goddard Space Flight Center, Greenbelt, Md.); Brinton, H. C.; Carpenter, D. L.; Bonner, F. M.; Heyborne, R. L. J. Geophys. Res., 74: 3517–28(July 1, 1969).

Simultaneous observations of positive ion composition, vlf Earth-to-satellite transmission, and whistlers have been obtained from the OGO 2 satellite during October 1965 in a polar, dawn–dusk orbit. As the satellite moves poleward above about 55° invariant latitude, sudden depletions of the light ion components of the topside ionosphere are observed, wherein the concentrations of H^+ and He^+ decrease by as much as an order of magnitude within 3°Λ. The light-ion trough correlates with similar rapid reductions in the propagation of both man-made and natural vlf signals received at the satellite, where signal intensities are observed to decrease by as much as 20 db and where whistler rates decrease abruptly within 3°Λ. Poleward of the trough, the depleted light-ion distributions are characterized by rapid fluctuations in concentration, which appear to correlate in some cases with significant enhancements in the vlf noise level. The combined evidence of the light-ion depletion and vlf cutoff further identifies the plasmapause as the often abrupt boundary of the plasmasphere. The abruptness of the light ion trough suggests the possibility that the mechanism responsible for the depletion results under certain conditions in a sharply defined heating and upward expansion of the lower atmosphere. Limited evidence of vlf absorption as well as abrupt increases in neutral density near the trough zone appears consistent with this possibility. (auth)

39388 PERIODIC FADING IN 42-MHz AURORAL BACKSCATTER. Sofko, G. J.; Kavadas, A. (Univ. of Saskatchewan, Saskatoon, Can.). J. Geophys. Res., 74: 3651–8(July 1, 1969)

During April and May 1964, high-speed polarization measurements of 42-MHz auroral backscatter were made at Saskatoon with a time-sharing polarimeter capable of measuring fading rates up to about 100 Hz. The fading is often very deep and quasi-periodic with pronounced power in the 5- to 25-Hz range and major peaks near 10 Hz. The spectral power becomes greater in the 5- to 10-Hz range when the auroral scatter intensity increases. The relationship between the scatter bursts and pulsating primary electron flux is discussed. (auth)

39389 ACOUSTIC-GRAVITY WAVES FROM AN ENERGY SOURCE AT THE GROUND IN AN ISOTHERMAL ATMOSPHERE. Cole, J. D.; Greifinger, C. (Rand Corp., Santa Monica, Calif.). J. Geophys. Res., 74: 3693–3703(July 1, 1969).

The pressure pulse generated in an isothermal atmosphere by an

energy source at the ground is calculated by the method of stationary phase from an integral representation of the pressure field previously derived by the authors. The first signal to arrive at any location is a high-frequency acoustic wave, followed by a low-frequency acoustic–gravity wave. The onset of the latter is marked by a sharp front, or caustic. At any instant (after the arrival of the caustic), there are three principal frequency components at any location, the lowest of which becomes dominant as time progresses. The qualitative features of the flow and the location of the caustic are also obtained from kinematic theory. The two alternative methods are essentially equivalent, but kinematic theory seems better adapted to the case of a slightly nonuniform medium. (auth)

39390 RADIATIVE RECOMBINATION OF ATOMIC OXYGEN IONS IN THE NIGHTTIME F REGION. Hanson, W. B. (Univ. of Canterbury, Christchurch, N. Z.). J. Geophys. Res., 74: 3720-2(July 1, 1969).

It is suggested that the ultraviolet emissions reported by Hicks and Chuff (1969) actually arise from the radiative recombination of O^+ ions and electrons in regions of enhanced ionization. (W.D.M.)

39391 FURTHER COMPARISON OF SPREAD-F AND BACKSCATTER SOUNDER MEASUREMENTS. Hower, G. L.; Makhijani, A. B. (Washington State Univ., Pullman). J. Geophys. Res., 74: 3723-5(July 1, 1969).

Attempts to compare backscatter measurements with results obtained by observation of scintillations of signals from radio stars or satellites and radar echoes obtained with oblique-incidence backscatter sounders are reviewed. In this note, these results are re-examined by using simultaneous radar and spread-F data on an hourly rather than a monthly basis and by using more detailed ray-path calculations. (W.D.M.)

39392 DISCUSSION OF PAPER BY L. P. BLOCK AND C.-G. FAELTHAMMER: EFFECTS OF FIELD-ALIGNED CURRENTS ON THE STRUCTURE OF THE IONOSPHERE. Schunk, Robert (Yale Univ., New Haven); Walker, James C. G. J. Geophys. Res., 74: 3747-9(July 1, 1969).

It is pointed out that confusion may arise from Block and Fälthammer's (1968) failure to distinguish between electric current and the flux of ionization carried by ambipolar diffusion. A reply by Block and Fälthammer is included. (W.D.M.)

39393 ELECTRIC FIELDS IN THE VICINITY OF AURORAL FORMS FROM MOTIONS OF BARIUM VAPOR RELEASES. Wescott, Eugene M.; Stolarik, John D.; Heppner, James P. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 74: 3469-87(July 1, 1969).

In August–September 1967 eleven barium vapor clouds were released during evening twilight between invariant magnetic latitudes of 67.3° to 68.1° from Andøya, Norway. Two flights (8 releases) occurred during moderate negative bays in H, whereas the third flight (3 releases) took place during a positive bay in H. Visual auroral displays were observed in the vicinity during all flights. In the negative bay situation, barium ion cloud motions were eastward and closely parallel to auroral arc alignments. Electric fields transverse to the magnetic field with intensities of 10 to 130 mV/m directed southward were observed. During the positive bay event the barium spanned the breakup transition region, with the two equatorward clouds moving westward while the poleward cloud went east. Observed reversals in direction were closely correlated with magnetic variations. North directed electric fields of up to 50 mV/m were found in the positive bay sector. In all events the ion cloud motions revealed that E was perpendicular to the ionspheric current, hence it is concluded that the auroral electrojets, both eastward and westward, are essentially Hall currents. The results illustrate that the magnitude of E driving ionospheric currents cannot be deduced solely from ground magnetic observations because of the variable ionospheric electrical conductivity. There is evidence that while E is large near an auroral arc, the field within is very low. Large gradients and/or irregularities in the E field are found to exist most of the time. These are revealed on three different time-space scales: from differences in velocity for parallel moving clouds, from velocity changes along the path of a given cloud, and in the form of rayed structure within a cloud. (auth)

39394 OBSERVATIONS ON THE TOTAL OZONE IN SOFIA DURING THE SOLAR ECLIPSE OF MAY 20, 1966. Bojkov, Rumen D. God. Sofii. Univ., Fiz. Fak., 61: 201-15(1966-67).

Changes in the ozonosphere above Sofia observed with a Dobson ozone spectrophotometer during the annular solar eclipse (88%) on May 20, 1966 are reported. The results are compared with the theoretical calculations. (W.D.M.)

39395 STUDIES OF AURORAL HYDROGEN EMISSIONS IN WEST-CENTRAL CANADA. III. PROTON AND ELECTRON AURORAL OVALS. Wiens, R. H.; Jones, A. Vallance (Univ. of Saskatchewan, Saskatoon). Can. J. Phys., 47: 1493-1503 (July 15, 1969).

A chain of patrol spectrograph stations was operated from 1964 to 1965 to cover the geomagnetic latitude range 55 to 78°N near geographic longitude 100°W. Absolute intensities of hydrogen alpha and the O I (λ 5577) lines have been derived from over 7500 spectrograms. From this data, average Hα and λ5577 zenith intensities, as a function of geomagnetic latitude and time, were derived. Results are also given for these averages for different ranges of K_p index. Plots were made of the λ5577 intensities from which estimates of the nightglow and proton-excited components had been subtracted. It was found that the center of the proton auroral oval lies a few degrees equatorward of that of the electron oval before midnight and crosses somewhat poleward of it after 0100 hours geomagnetic. The average proton and electron precipitation zones overlap considerably. With increasing magnetic disturbance, the proton precipitation zone spreads equatorward and increases considerably in its peak intensity, although its intensity is not very sensitive to K_p at geomagnetic latitudes above 70°. For low K_p, the Hα intensity distribution is rather symmetrical about midnight, but for high K_p the intensities are highest before midnight and the proton auroral oval has its maximum equatorward extent around 2100 hours. (auth) (Canada)

39396 MEASUREMENT OF RADIO-METEOR IONIZATION PROFILES. Jones, J. (Univ. of Western Ontario, London). Can. J. Phys., 47: 1467-73(July 15, 1969).

The theory of a method for the determination of electron line density profiles of underdense radio meteors is developed, and the effects of cosmic noise, winds in the meteor region, and ambipolar diffusion on the measured profiles are estimated. The design of a device for the automatic determination of radio-meteor ionization profiles is described, together with some results obtained using it in conjunction with the Ottawa–London (Ontario) backscatter system. (auth) (Canada)

39397 THE BOUNDARY OF TRAPPED E ≥ 280-keV ELECTRONS AND THE LOCATION OF ELECTROJET STREAMS IN THE IONOSPHERE. Afonina, R. G.; Fel'dshtein, Ya. I. Kosm. Issled., 7: 312-14(Mar.-Apr. 1969). (In Russian).

Following up earlier observations of energetic trapped electrons in the external radiation zone at a height of 1100 km, the relative position of the high-latitude boundary of trapping of the E ≥ 280-keV electrons and of electrojet streams in the ionosphere was investigated, using the facilities of Satellite 38S, launched on September 23, 1963. It was assumed that the count rate at the boundary of the trapping region amounts to 1/100 of the maximum count rate in the internal radiation zone. The latitude was determined by interpolation between latitude data with count rates of 1 and 10, respectively. Only in two cases was it possible to determine the location of an eastern electrojet stream with respect to the boundary of trapping of E ≥ 280-keV electrons. Shifting of the boundary is attributed to the spreading of the originally closed lines of force during periods of magnetic perturbation. The boundary tended to shift toward the equator when the magnetic perturbation increased. (TTT)

Low-Temperature Physics

Refer also to abstracts 38265, 38363, and 39812.

39398 INDUCTANCE OF CIRCUITS CONTAINING A SUPERCONDUCTING PLATE. Celli, V.; DuVall, B.; Manson, R. (Univ. of Virginia, Charlottesville). J. Appl. Phys., 40: 3075-7(July 1969).

Using the London theory the inductance of a system consisting of a long straight conductor of uniform cross section situated parallel to a nearby superconducting plate was examined. Explicit formulas are derived for the particular cases of conductors having cylindrical, rectangular, and thin-film cross sections and the limitations of the theory are discussed. The conclusions indicate that measurements of the inductance of such a system can be used to determine the penetration depth of a superconductor. (auth)

39399 SECOND SOUND IN SUPERFLUID HELIUM. Ichiyanagi, Masakazu (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 41: 275-84(Feb. 1969).

The problem of the propagation of second sound in superfluid helium is studied. The second sound wave is assumed to be described by a set of variables, the local energy and local energy flux densities. Relaxation function expressions are obtained for the thermal conductivity, χ, which is analogous to the normal

thermal conductivity κ_T, as is distinct from the abnormal thermal conductivity due to the counterflow of the super and normal components, and also for the kinetic coefficients ξ_1, ξ_3, ξ_4. It is pointed out that, to the thermal conductivity χ, a restoring force due to temperature is essential. (auth)

39400 KINETIC THEORY OF COLLECTIVE MODES IN CLASSICAL LIQUIDS. Chihara, Junzo (Japan Atomic Energy Research Inst., Ibaraki). Progr. Theor. Phys. (Kyoto), 41: 285-95(Feb, 1969).

By solving the linearized Vlasov-Boltzmann equation it is shown that zero sound can exist in classical liquids. The effective interatomic potential is shown to be expressed in terms of the direct correlation function. The real and imaginary parts of the frequency are expressed analytically for both small and large values of wave-vector k, but in general are obtained numerically. In this solution of the dispersion relation, first (ordinary) sound and zero sound originate from the same pole; the former is the solution for smaller k and the latter is that for larger k. It is believed that the collective modes observed in classical liquids by neutron-scattering experiments should be interpreted as zero sound. The imaginary part of the diffusion pole, which contributes to the line width of the quasi-elastic peak, becomes small for the wave vector where the form factor S(k) has peaks. (auth)

39401 DYNAMIC CRITICAL FLUCTUATION OF SUPERCONDUCTIVITY ORDER PARAMETER ABOVE THE TRANSITION POINT. Tsuzuki, Toshio (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto), 41: 296-306(Feb, 1969).

The dynamic correlation function of the fluctuation field in a dirty superconductor above the transition point is investigated. It is determined self-consistently in the critical range of temperature where the mean field theory breaks down and interactions among fluctuation modes must be taken into account. The correlation function is diffusional-type, with a diffusion constant that becomes singular as $(T/T_c - 1)^{1-(4/d)}$, where d is dimensionality. The inverse correlation length is proportional to $(T/T_c - 1)^{2/d}$ and is independent of mean free path of electron. Electric conductivity of a bulk system in the critical range contains a term that increases like $(T/T_c - 1)^{-\frac{1}{2}}$ and is independent of mean free path. However, in the case of a film system, a problem arises. (auth)

39402 LONG-DISTANCE BEHAVIORS OF THE PAIR DISTRIBUTION FUNCTION OF DEGENERATE AND NON-DEGENERATE BOSE FLUIDS. Morita, Tohru; Hara, Hiroaki (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 41: 60-87(Jan. 1969).

The formalism proposed for degenerate Bose fluids by one of the authors (T. Morita, Prog. Theor. Phys. 39: 1100(1968)) is extended for the calculation of the one- and two-particle distribution functions. With the aid of the diagram expansion, it is shown that the long-distance $1/r$ and $1/r^2$ behaviors of the pair distribution function of the degenerate ideal Bose gas are exactly canceled in degenerate interacting Bose fluids in general. In the proof, it is assumed that $vk/k \to \infty$ as $k \to 0$ for the weakly interacting case and $\Sigma_d(k,0)/k \to \infty$ as $k \to 0$ for the general case, where vk and $\Sigma_d(k,0)$ are the Fourier transforms of interacting potential and of a generalized binary collision kernel, respectively. It is stressed that the Hartree-Fock approximation is insufficient in showing the cancellation of the $1/r^2$ term. In fact, the cancellation is attained by taking account of the averages of the type: $\langle \tilde{a}^*_{p+k} \tilde{a}_k \tilde{a}_p \rangle$ and $\langle \tilde{a}_p, \tilde{a}_k, \tilde{a}_{p+k} \rangle$. For nondegenerate case the $1/r^2$ behavior, which appears just above the λ point of the ideal Bose gas, is also shown to be canceled in interacting Bose fluids. (auth)

39403 KONDO EFFECT IN SUPERCONDUCTOR. Takano, Fumihiko; Matayoshi, Seitaro (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto), 41: 45-59(Jan. 1969).

The Kondo effect in a superconductor is investigated by using the double-time Green function method of Nagaoka. It is shown that the exact solution of the Bloomfield-Hamann equations can be obtained in this case. The main difference is the presence of the energy gap in the state density function, and the solution is shown to have some arbitrary functions arising from this energy gap. Using this solution and taking the simplest form for the arbitrary function, the the position of the bound state in the energy gap is investigated. It is shown that the bound state exists for antiferromagnetic coupling but not for ferromagnetic. It is also shown that the result does not coincide with those of Fowler and Maki or of Soda et al., but coincides with the exact result in the classical limit. (auth)

39404 SUPERCONDUCTING TUNNELING THROUGH THE BARRIER WITH PARAMAGNETIC IMPURITIES. Shiba, Hiroyuki (Osaka Univ.); Soda, Toshio. Progr. Theor. Phys. (Kyoto), 41: 25-44(Jan. 1969).

The tunneling current between superconductors through the barrier with paramagnetic impurities is calculated on the Anderson-Appelbaum model. In order to investigate how the Kondo effect influences the tunneling current of single-particle excitations and Josephson current, the tunneling current was calculated on the basis of a perturbational treatment for the scattering of electrons by paramagnetic impurities. The possible effects of the localized excited states in the energy gap on these tunneling currents were examined, assuming that paramagnetic impurities in the insulating barrier are classical spins. (auth)

39405 PRESSURE-DEPENDENT PAIR BREAKING IN SUPERCONDUCTING $La_{3-x}Ce_x$ In ALLOYS. Maple, M. B.; Kim, Kangsoo (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett., 23: 118-20(July 21, 1969).

A minimum was observed in the variation of the superconducting transition temperature of $La_{3-x}Ce_xIn$ alloys with pressure. From this it is inferred that the pair-breaking parameter initially increases with pressure and then goes through a maximum associated with a transition of the Ce impurity from a magnetic to nonmagnetic state. (auth)

39406 SURFACE NUCLEATION AND BOUNDARY CONDITIONS IN SUPERCONDUCTORS. Fink, H. J. (Atomics International, Canoga Park, Calif); Joiner, W. C. H. Contract AT(04-3)-701. Phys. Rev. Lett., 23: 120-3(July 21, 1969).

The surface nucleation field was calculated as a function of the slope of the superconducting order parameter at the surface of a semi-infinite superconducting half-space. When the order parameter increases on approaching the surface, as would be the case in the presence of a surface region of enhanced transition temperature, nucleation fields larger than those expected for a uniform sample are predicted. Cold working the surface on an InBi foil produces this condition and qualitatively confirms the prediction. (auth)

39407 THERMAL FLUCTUATIONS AND THE JOSEPHSON SUPERCURRENT. Anderson, J. T.; Goldman, A. M. (Univ. of Minnesota, Minneapolis). Contract AT(11-1)-1569. Phys. Rev. Lett., 23: 128-31(July 21, 1969).

The effects of thermal fluctuations on the dc Josephson effect are examined experimentally through measurements of the current-voltage characteristic. The results are compared with a calculation of Ambegaokar and Halperin, which uses an analogy with the Brownian motion of a particle in a field of force. (auth)

39408 THEORETICAL SUPERCONDUCTING TRANSITION TEMPERATURES AND THE POSSIBILITY OF SUPERCONDUCTIVITY IN Mg. Allen, Philip B.; Cohen, Marvin L. (Univ. of California, Berkeley). Solid State Commun., 7: 677-80(May 1969).

Theoretical calculations for the superconducting transition temperatures of Zn, Cd and Be are presented. The results are in excellent agreement with experiment. Predictions are made for Mg. (auth) (UK)

39409 PRESSURE DEPENDENCE OF THE TEMPERATURE OF THE TRANSITION OF THE COMPOUND Bi_2K INTO THE SUPERCONDUCTING STATE. Alekseevskii, N. E. JETP Lett. (USSR) (Engl. Transl.), 9: 347-9(May 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 571-4(May 20, 1969).

Earlier experiments (Zh. Eksp. Teoret. Fiz., 20: 200(1952)) to determine the effect of pressure on T_c of Bi_2K were performed only at a pressure ~1500 atm. Results reported here of measurements in the range from 0 to 10,000 atm. show T_c varies nonlinearly with pressure. A brief theoretical discussion of the results is given. (L.M.T.)

39410 STUDY OF THE SUPERCONDUCTIVITY OF ANTIMONY UNDER PRESSURE AND A SEARCH FOR SUPERCONDUCTIVITY IN ARSENIC. Wittig, J. (Univ. of California, San Diego, La Jolla). J. Phys. Chem. Solids, 30: 1407-10(June 1969).

The high-pressure phase of antimony stable above 85 kbar is superconducting. The transition temperature is 3.55°K at 85 kbar, decreasing very slightly with pressure. Neither an analogous phase transformation nor superconductivity was found in arsenic up to 200 kbar. (auth) (UK)

39411 PERSISTENT CURRENT DISTRIBUTION ON THE SUPERCONDUCTING SHIELD OF THE CIOFFI MAGNET. Schulz-Dubois, E. O. (IBM Research Lab., Zurich). Cryogenics, 9: 194-200(June 1969).

The superconducting magnet attributed to Cioffi employs a shield of sheet superconductor. The shielding effect is considered as due to the induced persistent current distribution on the shield. The current distribution on shields of appropriate geometries is evaluated from the electromagnetic boundary conditions. Examination of Cioffi's original shielding geometry reveals several spots of singularly high current density. Critical phenomena at these

spots may account for irreversible breakdown of the shielding action. A class of novel magnet geometries is proposed where the current density on the shield is uniform. Magnets of these geometries should function reversibly up to the critical field of the shielding superconductor. (auth) (UK)

39412 ELECTROMAGNET WITH INDUCTIVE SUPERCONDUCTING SHIELDING. Ball, H. (Siemens AG, Karlsruhe, Ger.); Schulz-Dubois, E. O. Cryogenics, 9: 201-8(June 1969).

An electromagnet with a suitably shaped superconducting shield was investigated. It was found that the gap field can be reliably computed and is highly homogeneous. With pure soft superconducting material the magnet performance is reversible up to the critical field; beyond that, a shaped boundary between normal and superconducting states may form, and the boundary advances, with delay, into the material as a result of ordinary skin effect. In hard superconductors, hysteresis-like frozen-flux effects are observed, from which the critical current density can be determined. (auth) (UK)

39413 MICROSCOPIC THEORY OF THE JOSEPHSON DIRECT CURRENT. Svidzinskii, A. V.; Slyusarev, V. A. Dokl. Akad. Nauk SSSR, 185: 296-8(Mar. 11, 1969). (In Russian).

Spatially inhomogeneous problems in superconductivity theory can be conveniently resolved in the formalism of equations for Green functions in configuration representation. However these equations are too complex, since they describe small-scale changes of the order parameter at atomic distances. Simpler equations could be obtained by properly averaging the order parameter. Although this procedure cannot be done in the general case, it can be carried out in concrete problems. A case is considered in which the spatial inhomogeneity is due to a potential barrier of width d, separating the same superconductors, In this system there are possible current states under conditions of thermodynamic equilibrium (the first Josephson effect). These current states are solved in terms of the transmission and reflection coefficients. The averaging over atomic distances is carried out in such a way as not to have an effect on the values of the expressions which depend only on the transmission and reflection coefficients. Complete calculation of the magnitude of the current can be carried out for small values of the transmission coefficient. (TTT)

39414 SUPERCONDUCTIVITY IN ONE-DIMENSIONAL SYSTEMS. Bhagavan, M. R. (London Univ.). J. Phys., C (London), 2: 1092-6(June 1969).

The Green function formalism of Bhagavan and Edwards (1967) is used to evaluate the relative magnitudes of the Peierls doubling and Cooper pairing vertices in one-dimensional systems. It is found that they are roughly the same. This indicates that the Peierls doubling process is likely to inhibit the formation of a superconducting state. (auth) (UK)

39415 ON THE RADIUS OF LINEAR QUANTUM VORTICES IN LIQUID HeII. Reut, L. S. (Odessa State Univ.). Ukr. Fiz. Zh., 14: 158-9(Jan. 1969). (In Russian).

In describing quantized vortex lines in superfluid helium, a classical model of an ordinary hydrodynamic linear vortex in an incompressible nonviscous liquid is often used with quantized value of the circulation. For a quantized vortex in liquid helium, the column radius of the vortex R_0 should be exactly determined by the vortex model itself, and should be a value on the order of the interatomic distance in helium-II. Experimental estimates for a linear ring vortex give a value of about 1.2 Å for R_0 at T = (0.3 to 0.6)°K. A theoretical estimate of R_0 at low temperatures can be obtained by beginning from a gas model and assuming that the normal component of helium-II is a mixture of ideal Bose-gases of phonons and rotons. The density of the superfluid component is given at various distances from the vortex axis at T = 1°K. The value of R_0 is given as a function of the temperature. The closeness of the estimated value of R_0 to the experimental value indicates that the gaseous phonon-roton model of superfluid helium is suitable for the approximate analysis of the structure of quantized superfluid vortices at T of about 1°K. (TTT)

39416 EFFECT OF PROTON AND DEUTERON IRRADIATION ON THE CRITICAL CURRENT DENSITY OF SUPERCONDUCTING Nb_3Sn DIFFUSION LAYERS. Wohlleben, K. (Siemens AG, Erlangen, Ger.). Z. Angew. Phys., 27: 92-7(June 1969). (In German).

Nb_3Sn diffusion layers were irradiated with 1-, 2-, and 3-MeV protons and 3-MeV deuterons at fluences of up to 2×10^{17} cm^{-2}. The superconducting critical current density, determined from the tube magnetization curve at 4.2°K, increases with the rising fluence, passes through a maximum and decreases again. The maximum j_c enhancement is approximately 10^6 A/cm^2, i.e., it is equivalent to a three- to sixfold j_c enhancement compared with the pre-irradiation values. The magnetic field H (25 to 50 kOe) has only little effect on the j_c enhancement. The different density of the pinning centers formed by the displaced atoms with primary energies above 20 keV explains the varying j_c enhancement values for the different ions. With that the minimum size of the clusters becoming effective pinning centers is about 75 Å. The calculated mean distance between the pinning centers is between 240 and 310 Å at the maximum j_c enhancement. Complete recovery from the j_c enhancement requires a temperature of approximately 800°C. (auth)

39417 EFFECT OF PRESSURE ON SUPERCONDUCTIVITY. Trofimenkoff, P. N.; Carbotte, J. P. (McMaster Univ., Hamilton, Ont.). Solid State Commun., 7: 661-4(May 1969).

The effect of hydrostatic pressure on the critical temperature of Al and Pb was calculated by solving the Eliashberg gap equations with kernels appropriate to the compressed state. Good agreement with experiment results was obtained. (auth) (UK)

39418 A CONSIDERATION ON THE STABILIZED CURRENT DENSITY IN COMPOSITE SUPERCONDUCTORS. Ihara, Seijiro; Kaiho, Katsuyuki (Electrotechnical Lab., Tokyo). Denki Shikensho Iho, 33: 272-84(Mar. 1969).

The expression for the stabilized current density in a composite superconductor is derived by the concept of the propagating velocity of the normal zone in the superconductor. The overall current density is found to be of the form $J_T = A^{-\frac{1}{2}} \cdot \gamma(H) \cdot f(m)$ where A is the cross-sectional area of the conductor, γ the thermal and electrical parameter, and f(m) the function of cross-sectional area ratio m between the stabilizer and the superconductor, respectively. For the given total cross-sectional area of the composite conductor, j_T increases monotonously with m and the optimum m is obtained at such value that j_T corresponds to the critical current density of the composite conductor $j_{cc} = j_c/(1 + m)$ where j_c is obtained from the usual $j_c - H_c$ curve for the superconductor. For the given cross-sectional area of the superconductor, on the other hand, j_T shows maximum value at m = 2. Temperature rise of the conductor after the magnet has quenched is calculated also, and it turned out that, for an increasing current, the burnout temperature is reached directly from a take-off point that exists in a cryogenic temperature. Safety limits of the electric current for composite superconductors are shown. (auth)

39419 ONE-INCH BORE, 55 kG STABILIZED SUPERCONDUCTING MAGNET. Aiyama, Yoshimichi; Kimura, Mitsuhiro, Denki Shikensho Iho, 33: 316-21(Mar. 1969). (In Japanese).

A small stabilized superconducting magnet was manufactured with the following specifications: 3 cm in inner-winding diameter, 12 cm in outer-winding diameter, 12 cm in winding length, 48.3 A in coil critical current, and 57.5 kG in maximum center field. Making use of copper-clad Nb-70 at. % Ti wire, 0.50 mm in outer diameter and 0.25 mm in core diameter, this magnet had the following characteristics: (i) no degradation, (ii) no training effect, and (iii) high sweep rate. Preparation of the superconducting wire and performance of the magnet are described. (auth)

39420 EXCESS NOISE IN SUPERCONDUCTING BOLOMETERS. Maul, M. K.; Strandberg, M. W. P.; Kyhl, R. L. (Massachusetts Inst. of Tech., Cambridge). Contract DA 28-043-AMC-02536(E). Phys. Rev., 182: 522-5(June 10, 1969).

A large excess of noise above that expected on the basis of thermal fluctuations was observed in the output of thin-film Sn superconducting bolometers. The noise spectrum was measured from 50 Hz to 4 MHz, with an additional measurement at 30 MHz as a function of applied magnetic field. The excess noise in the 100-KHz to 30-MHz range is found to be damped by the application of a perpendicular field of from 3 to 15 G. There is a $1/f^2$ component at lower frequencies which is believed to be due to the detection of acoustic bubbling in the liquid helium. This portion of the noise was not affected by the application of a magnetic field. (auth)

39421 QUANTUM PHASE OPERATORS AND THE JOSEPHSON PLASMA RESONANCE. Nieto, Michael Martin (Univ. of Copenhagen). Nuovo Cim., 62B: 95-102(July 11, 1969).

Using the recently developed quantum phase operators, a new derivation is given of the Josephson plasma resonance. The discussion emphasizes the natural and rigorous role that phase operators have in describing coherence phenomena. (auth)

39422 HIGH-PRESSURE SUPERCONDUCTING POLYMORPH OF CADMIUM TIN DIARSENIDE. Katzman, H. (Univ. of California, Los Angeles); Donohue, T.; Libby, W. F.; Luo, H. L.; Huber, J. G. J. Phys. Chem. Solids, 30: 1609-11(June 1969).

A superconducting polymorph of $CdSnAs_2$ prepared at about 60 kbar and 25 to 450°C was investigated at atmospheric pressure and temperature. Its crystal structure is Bl(NaCl), with a lattice constant of 5.679 to 5.695 Å, depending on the temperature at which it was prepared. The superconducting transition temperature is also a function of the preparation temperature and varies from 1.79° to 2.29°K. (auth) (UK)

39423 RESULTS AND DEFICIENCIES OF THE PRESENT THEORY OF TYPE-II SUPERCONDUCTORS. Eilenberger, Gert (Univ., Cologne). pp 254-63 of Festkoerper Probleme. VIII. Madelung, O. (ed.). New York, Pergamon Publishing Co., 1968. (In German).

Gorkov's equations, which form the basis and starting point for the present theory of type-II superconductors are discussed. Theoretical work based on these equations is given in a table representing the H–T plane, which shows that many results are still lacking and that quantitative comparison between theory and experiment is hardly possible. New equations, derived from Gorkov's, are proposed as a convenient starting point for further theoretical work which aims at removing this deficiency. 25 references. (auth)

39424 EFFECT OF LS COUPLING TO RESIDUAL ATTENUATION OF SHEAR WAVES IN SUPERCONDUCTING LEAD. Shimada, Katsumi (Osaka City Univ.). J. Phys. Soc. Jap., 27: 74-80(July 1969).

The effect of LS coupling is very important in the transport phenomena of heavy metals. Its effect on the residual attenuation of shear waves in superconducting lead just below the transition temperature is discussed. From the results of the calculation, it is found that the effect of LS coupling is particularly important in the case that the wave vector and the polarization vector are parallel to (110) and to (1$\bar{1}$0), respectively. (auth)

39425 THEORY OF PINNING EFFECT ON THE NONLINEAR RESISTANCE IN THE MIXED STATE OF TYPE-II SUPERCONDUCTORS. Sugahara, Masanori; Ohta, Tokio (Yokohama National Univ., Japan). Jap. J. Appl. Phys., 8: 801-5(June 1969).

A mechanism is proposed for the nonlinear flux flow resistance in the mixed state of type II superconductors. Besides the frictional drag which is responsible for the linear resistance, the flux line motion is subjected to the pinning effects, which are appreciable especially when the Lorentz-like driving force is small, that is to say, in the small current region. The flux line is pinned down for a time τ_r, which decreases with the increase of the Lorentz-like force, at each pinning center and for the rest time τ_p, no voltage appears while the currents flow. The dislocation-immigration analog in the imperfect lattice is used for the line motion to calculate τ_r and the result shows the nonlinear resistance in good agreement with the experimental results. (auth)

39426 NUCLEATION AND PROPAGATION OF FLUXONS IN THIN CYLINDRICAL SPECIMENS OF TYPE II SUPERCONDUCTORS. Boato, G.; Boebel, G.; Cantoni, F.; Gallinaro, G.; Meneghetti, L. (Univ., Genoa). Nuovo Cim., 62B: 153-62 (July 11, 1969).

Some experimental results on the behavior of fluxons in thin cylindrical specimens of Pb–Tl 50% alloy are presented. Experimental proof of the existence of the barrier fields was obtained. Moreover, the propagation velocity of fluxons along the specimens was measured. This velocity was calculated by means of a simple theoretical model and obtained reasonable agreement with the experimental results. (auth)

39427 THEORY OF GAPLESS SUPERCONDUCTIVITY IN ALLOYS WITH PARAMAGNETIC IMPURITIES. Rusinov, A. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Theor. Fiz., 56: 2047-56(June 1969). (In Russian).

The theory of superconductors with paramagnetic impurities is extended to the case when scattering of electrons by an impurity of spin S leads to the appearance of local states lying within the gap. It is shown that the order parameter near the impurity does not change appreciably. For finite impurity concentrations these states are responsible for broadening of the gapless superconductivity region observed experimentally. It is assumed in the calculations that the impurity spin S is a classical vector. (auth)

39428 CORRELATION OF SUPERCONDUCTING AND METALLURGICAL PROPERTIES OF A Ti–20 AT. PERCENT Nb ALLOY. Baker, C.; Sutton, J. (Central Electricity Research Labs., Leatherhead, Eng.). Phil. Mag., 19: 1223-56 (June 1969).

The effects of heat treatment and cold work on the superconducting properties of Ti-20 at. % Nb were studied by measurement of magnetization, M(H), critical current density, J_c(H), and transition temperature, T_c. The metallurgy was investigated by electron and optical microscopy and x-ray diffraction. Quenching the recrystallized alloy from the single phase β region above 500°C produced a martensitic α'' phase characterized by H_{c_1} = ~50 koe, T_c = 6.5°K and a high J_c arising from pinning of flux lines by the α'' structure. After very short aging times at 330°C the α'' reverted to the β phase and H_{c_1} and T_c fell to 15 koe and 4.5°K respectively and J_c dropped by several orders of magnitude. On further aging ω-Ti precipitated and H_{c_1} and T_c increased because of Nb enrichment of the matrix. Pinning by the ω precipitate caused J_c to increase. A pronounced peak effect in the J_c(H) and M(H) curves was studied in detail. There was strong evidence for a barrier to flux line entry into the pinning centers below the peak field. This barrier may have been due to a Nb-rich shell surrounding the ω precipitate. If the quenched alloy was worked, the α'' phase was retained and T_c and H_{c_1} were unaltered. On aging, the α'' reverted to strained β but T_c, H_{c_1} and J_c did not drop as in the recrystallized alloy. Prolonged aging produced a significant growth of α-Ti precipitate, and T_c, H_{c_1} and J_c all increased as in the recrystallized alloy. (auth) (UK)

39429 HIGH-AMPLITUDE TORSIONAL OSCILLATIONS OF A DISK IN A VISCOUS FLUID. Folse, Raymond Francis Jr. Baton Rouge, La., Louisiana State Univ., 1968. 50p.

Thesis.

Measurements have been made of the logarithmic decrement and period of disks, of radius 3.0 to 8.5 cm, performing torsional oscillations at amplitudes in the range 0.01 to 1.6 rad in fluids of kinematic viscosity 0.29 to 3.06 centistokes. Both the logarithmic decrement and period were observed to depend on the amplitude of oscillation in qualitative agreement with a theory due to Rosenblat which predicts amplitude effects due to secondary flow. It is shown that a consequence of the theory is that the relative changes in the added moment of inertia I_a and the logarithmic decrement D should be independent of the kinematic viscosity of the fluid and the size of the disk. The observed relative changes were smaller than predicted and were dependent on the radius of the disk but were relatively insensitive to kinematic viscosity, disk thickness, or distance to the outer boundaries. The observed relative changes are given by an empirical correlation. These empirical correlations point out the existence of critical amplitudes which must be exceeded before amplitude effects occur. Below 0.2 rad the period was constant within 0.001% and below 0.3 rad the logarithmic decrement was constant within 0.3%. New corner parameters for the oscillating disk were obtained from the data in the range $0.01 < \epsilon < 0.2$ rad where ϵ is the amplitude of oscillation; these parameters show that the effect of the fluid located at the sharp corner of the disk, where the plane faces and cylindrical edge meet, is to increase the logarithmic decrement but to have no effect on the added moment of inertia. This result is used to correct the pile of disks measurements of the normal fluid density of liquid helium II. (Disser. Abstr.)

39430 SUPERCONDUCTING FLUCTUATIONS IN A MAGNETIC FIELD. Bergmann, G. (Univ., Goettingen, Ger.). Z. Phys., 225: 430-43(1969).

The rounding of the transition curve is measured for superconducting bismuth films in a perpendicular magnetic field. The contribution of the fluctuating superconducting wave function to the conductivity above T_c in an applied magnetic field is calculated with a simple model. The allowed states of the fluctuations are cylinders in momentum space. During their life time the fluctuating superconducting electrons can be accelerated by an electrical field and contribute to the conductivity. Experiment and theory are in fair agreement. Some information is obtained about the Pauli spin paramagnetism of the electrons. (auth)

39431 INFLUENCE OF STRUCTURAL MODIFICATIONS AND METALLURGICAL TREATMENTS ON PROPERTIES OF SUPERCONDUCTING MATERIALS. Bocquet, Jean-Pierre (Ecole des Mines, Paris). Metaux (Corros.-Ind.), 44: 49-69 (Feb. 1969). (In French).

The physical parameters on which the limits of the superconducting state depend are theoretically reviewed. The manner in which metallurgical factors affect these physical parameters is investigated. As the different limits of the superconducting state are variously sensitive to the microstructure, the effect of the structural modifications and the metallurgical factors on the primary, secondary, and tertiary properties of the superconducting state is studied. (J.S.R.)

39432 TRANSITION TEMPERATURES OF LAMINATED INTERMETALLIC COMPOUNDS Nb_3Sn AND $Nb_3Al_{0.8}Ge_{0.2}$. Tanaka, Eihachiro; Fukuda, Takeji; Kuma, Shoji; Yamashita, Tsutomu; Onodera, Yutaka (Tohoku Univ., Sendia). Appl. Phys. Lett., 14: 389-90(June 15, 1969).

Data are presented on the transition temperatures and the critical currents of laminated Nb_3Sn and $Nb_3Al_{0.8}Ge_{0.2}$ tapes. The samples were prepared by rolling techniques and diffusion process. At first, the plates were prepared by accumulating foils of materials alternatively. Then the plates were rolled to a flexible tape and heat treated. By heat treatment the transition temperature T_c of Nb_3Sn tape increases and reaches the constant value ≃18.0°K for 10 min at 1050°C. For $Nb_3Al_{0.8}Ge_{0.2}$, T_c = 19.2°K is obtained by heat treatment at 1600°C for 1 min and annealing at 760°C for 2 h. The critical currents of the samples are discussed. (auth)

39433 MAGNETIZATION STUDIES ON SUPERCONDUCTING VANADIUM–GALLIUM. Decker, D. L.; Laquer, H. L. (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys., 40: 2817-22(June 1969).

The temperature dependence of the critical fields of V_3Ga has been measured up to 70 kOe using ac and dc magnetization techniques. For a material with a transition width of 26 mdeg at a transition temperature, T_c, of 14.19°K, one calculates from the slope ($dH_{c2}/dT = -43.2$ kOe/deg) and curvature of the H_{c2} vs T curve, the Ginzburg–Landau parameter, $\kappa = 40 \pm 2$, the Pauli paramagnetism parameter $\alpha = 2.28 \pm 0.04$, and the spin–orbit scattering constant $\lambda_{so} = 0.6 \pm 0.1$. No evidence for H_{c3} was detected and the experimentally difficult upper limit to H_{c1} appears to be about three times as large as calculated from the theories. (auth)

39434 STABILITY LIMIT OF THE SUPERHEATED MEISSNER STATE DUE TO THREE-DIMENSIONAL FLUCTUATIONS OF THE ORDER PARAMETER AND VECTOR POTENTIAL. Fink, H. J.; Presson, A. G. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. Phys. Rev., 182: 498-503(June 10, 1969).

The upper experimental magnetic field H_u at which the metastable, superheated Meissner state becomes unstable against infinitesimally small fluctuations of the order parameter and the vector potential was calculated near the transition temperature T_c. For $\kappa \leq 1.10$, the stability limit is determined by fluctuations of infinite wavelength, and the field H_u coincides with the maximum field H_{sh} at which solutions of the Ginzburg–Landau equations cease to exist. For $\kappa > 1.10$, the stability limit is determined by fluctuations of finite wavelength, and the value of H_u is smaller than H_{sh}. For example, at $\kappa \approx 4.25$, $H_u/H_c \approx 1$, and when $\kappa \to \infty$, $H_u/H_c \approx 0.745$ (H_c is the thermodynamic critical field). For $\kappa \geq 1.10$, one finds within 1% accuracy $H_u/H_c = (\frac{1}{3}\sqrt{5})[1 + (2\kappa)^{-\frac{1}{2}}]$. (auth)

39435 NOISE IN THE ac JOSEPHSON EFFECT. Stephen, Michael J. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., 182: 531-8(June 10, 1969).

A Langevin treatment of noise in the ac Josephson effect is given at finite temperatures, including the quasiparticle tunneling currents. Using quasilinear methods, the stability and small oscillations of the system are investigated. It is found that the system is unstable for phase fluctuations and that these phase fluctuations lead to a Lorentzian line for the radiation emitted from a Josephson junction. The power spectrum of voltage fluctuations of the junction and the statistics of the emitted radiation are investigated. (auth)

39436 INTERACTION OF ac JOSEPHSON CURRENTS WITH SURFACE PLASMONS IN THIN SUPERCONDUCTING FILMS. Ngai, K. L. (Univ. of Chicago). Phys. Rev., 182: 555-68 (June 10, 1969).

The coupling of low-frequency surface plasmons to the ac Josephson currents in superposed thin dielectric and superconducting metal films is examined. The I–V characteristics for various superposed film systems are derived. The theory permits the magnitude of the parameters entering in the expression for the I–V characteristics, as well as their dependence on various quantities (temperature, mean free path, etc.), to be determined and compared with existing experiments. The theory of steplike structures in the I–V characteristics of a single Josephson junction was extended to multiple films, and it was found that more than one series of such steplike structures is possible. The theory provides a natural explanation for a three-film tunneling experiment of Giaever. Finally, the modifications of the dispersion relations for surface plasma oscillations in multiple-film systems, when admitting the presence of the ac Josephson effect, are derived. (auth)

39437 TUNNELING INTO LOW-CARRIER-DENSITY SUPERCONDUCTORS. Koonce, C. S. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 182: 568-73 (June 10, 1969).

A theory of tunneling between a normal metal and a low-carrier-density superconductor at zero temperature is developed. Because of the small Fermi energy of low-carrier-density superconductors and the energy dependence of the tunneling matrix elements for these junctions, the conductance-versus-voltage curves are quite different from those for tunneling between a metal and a high-density (metallic) superconductor. The tunneling displays both the voltage-dependent conductance associated with tunneling between a metal and a degenerate semiconductor and the peaks in conductance arising from the large quasi-particle density of states at voltages slightly larger than the superconducting energy gap. (auth)

39438 SUPERCONDUCTIVITY IN A MOLECULAR FIELD. I. Takada, Satoshi; Izuyama, Takeo (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 41: 635-63(Mar. 1969).

The Fulde–Ferrel model, in which a molecular field is acting on the spins of the conduction electrons responsible for superconductivity, is investigated. The superconducting state described by the condensate wave function oscillating in space, and giving rise to a gapless energy spectrum, is shown to be the ground or equilibrium state for some values of the pairing interaction and the molecular field. Thermodynamic properties of such gapless superconducting states are investigated extensively. Special attention is paid to the properties of the phase transitions from such superconducting states to the other states. (auth)

39439 CALCULATION OF THE ROTON–ROTON CONTRIBUTION TO THE VISCOSITY OF LIQUID He II. Toigo, F. (Univ., Padua). Nuovo Cim., 62B: 103-8(July 11, 1969).

A new potential, which accounts for the roton–roton interaction, is proposed. Using this potential without any adjustable parameters, the calculated roton–roton contribution to the viscosity of He II in the temperature range between 1.35 and 1.9°K is found to be in qualitative agreement with the experimental value. (auth)

39440 FAST-NEUTRON DAMAGE AND THE CURRENT-CARRYING CAPACITY OF NIOBIUM NITRIDE. Sadagopan, V. (Massachusetts Inst. of Tech., Cambridge); Gatos, H. C.; Hechler, K.; Saur, E. Z. Phys., 225: 231-6(July 1969).

Niobium nitride samples were irradiated with fast neutrons to a total dosage of 3.7×10^{19} nvt. The current-carrying capacity of the samples before and after irradiation was determined. Significant enhancement of the current carrying capacity of the samples was found to result from irradiation (particularly in the 30 to 80 kG range) apparently due to neutron-induced defects acting as pinning centers for the fluxons. (auth)

39441 LOCAL BOILING AND CAVITATION IN HEAT-INDUCED COUNTERFLOW OF He II. Broadwell, James E.; Liepmann, Hans W. (California Inst. of Tech., Pasadena). Phys. Fluids, 12: 1533-5(Aug. 1969).

Local boiling, cavitation, and cavitation collapse have been observed in the heat induced counterflow of He II in a convergent–divergent nozzle. These observations are described and shown to be qualitatively and quantitatively in agreement with the two fluid equations supplemented by the Gorter–Mellink force. (auth)

Plasma and Thermonuclear Physics

Confinement and Heating

Refer also to abstract 39501.

39442 (NP-17962) ANOMALOUS ABSORPTION OF AN ELECTROMAGNETIC WAVE IN A COLLISIONLESS PLASMA. PLASMA HEATING IN A STRONG UHF-FIELD. 9th International Conference on Phenomena in Ionized Gases, Bucharest, August 31–September 6, 1969. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1969. 31p. (In Russian and English). Dep.

Separate abstracts were prepared for three papers pertaining to the above subject and scheduled for presentation at the subject conference. The papers appear both in Russian and in English. (M.O.W.)

For abstracts of individual papers see: 39443, 39460, and 39501.

39443 (NP-17962, pp 28-31) AN ANOMALOUS HEATING OF PLASMA ELECTRONS IN A STRONG SHF FIELD. Batanov, G. M.; Sarksian, K. A.; Silin, V. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). (CONF-690803-6).

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

The electron temperature variations in a rarefied collisionless magnetoactive plasma due to the variations of the shf field strength were investigated. Oscillograms of probe collector current are given. (M.O.W.)

39444 CALCULATIONS OF THE DRIFT VELOCITY OF FULLY IONIZED GAS IN MAGNETIC FIELD. Lelakowska, Krystyna (Tele- and Radiotechnical Inst., Warsaw). Postepy Fiz., 20: 181-91(1969). (In Polish).

A method is given for determining the drift velocity of a fully ionized gas in the presence of a steady homogeneous magnetic field. It is assumed in a first approximation that all electrons have equal thermal velocity and these velocities are subordinate to Maxwell distribution. The calculation was carried out by using the Boltzmann equation for the distribution velocity function of the particles appearing in the gas. (auth)

39445 DOUBLE-TOROIDAL HYDROMAGNETIC-EQUILIBRIUM CONFIGURATIONS WITHIN A PERFECTLY CONDUCTING SPHERE. Morikawa, G. K. (New York Univ., N. Y.). Phys. Fluids, 12: 1648-51(Aug. 1969).

A one-parameter family of exact hydromagnetic-equilibrium solutions is found describing a plasma of finite pressure ($0 \leq \beta \leq 1$) confined by a force-free magnetic field contained within a perfectly conducting sphere. (auth)

Diagnostics

39446 (LA-tr-69-12) APPLICATION OF GAS LASERS TO ELECTRON DENSITY MEASUREMENTS IN PLASMA. Rozkwitalski, Zbigniew. Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from Postepy Fiz., 19: 383-401(1968). 22p. Dep. CFSTI.

An abstract of this article from the original Polish appeared in NSA 23: 1381. (L.M.T.)

39447 PLASMA SPECTROSCOPY. Marr, Geoffrey V. New York, American Elsevier Publishing Company, Inc., 1968. 326p. $21.50.

The following chapters are included: plasma fundamentals, absorption and emission of radiation, spectra of atoms, electronic spectra of diatomic molecules, bound–free transitions, spectral radiation in external fields, free–free transitions, oscillator strengths, shape and width of spectral lines, and plasma diagnostics. (M.O.W.)

39448 DETERMINATION OF HIGH GAS-STREAM TEMPERATURES FROM SHORT-EXPOSURE PROBE RESPONSES. Giedt, Warren H. (Univ. of California, Davis); Corallo, Richard A. ISA (Instrum. Soc. Amer.) Trans., 8: 43-51(1969).

Several techniques have been developed for determination of very high gas-stream temperatures from responses of probes exposed for suitably limited times in the gas stream. In contrast to the conventional concept of measuring some property of a sensor when it is in thermal equilibrium with the gas, these methods are based on inferring the temperature from the transient response of the sensing elements employed. They depend on the heat transfer from the gas stream to the sensor being a known or determinable function of the temperature difference between the stream and the sensor. Actual sensor temperatures are held to moderate values. Although radiation effects are thus hopefully reduced and the danger of sensor destruction eliminated, very accurate measurements of sensor response are required. The principles involved in single- and dual-element transient and intermittent probes are reviewed. Factors influencing the accuracy of predicted temperatures are discussed. Typical probes and measurements in gas streams having temperatures up to 7200 R are described. These include recent results obtained with hemispherical sensing elements. It is concluded that transient and intermittent probe measurements can provide quantitative information about temperature levels and distributions in gas streams in the 2000- to 8000-R range. (auth)

39449 CALCULATIONS OF HYDROGEN LEVEL POPULATIONS AND POSSIBILITIES FOR HIGH-TEMPERATURE PLASMA DIAGNOSTICS. Abramov, V. A.; Kuznetsov, E. I.; Kogan, V. I. At. Energ. (USSR), 26: 516-20(June 1969). (In Russian).

The populations of hydrogen atomic levels (n = 2 to 5) in a steady-state nonequilibrium plasma are calculated for a wide range of plasma densities and temperatures [$n_e = (10^8$ to $10^{16})$ cm^{-3}, $T_e = (6.5$ to $1500)$ eV]. Possibilities of using the results for high-temperature plasma diagnostics are discussed (determination of impurity concentration, "cost of an electron," calculation of radiation losses, etc.). The results are tabulated. (auth)

39450 EFFECT OF LONGITUDINAL MAGNETIC FIELD ON LOW PRESSURE PLASMA FLOW. Akazaki, Masanori; Nomoto, Yukiharu (Kyushu Univ., Fukuoka). Kyushu Daigaku Kogaku Shuho, 41: 962-7(Dec. 1968). (In Japanese).

Using double-probe method, electron density N_e and electronic temperature T_e were measured for low-pressure argon plasma produced by high frequency induction and flowing in a longitudinal magnetic field. Magnetic flux density was varied from 0 to 11 kG. As the flux density increases, N_e decreases at first, and then increases when B exceeds a certain value B_m. T_e shows rapid increases at first, then saturates and begins to decrease with large B. Using a simple model of magnetic field distribution, and taking account of bipolar diffusion and mirror reflection of electrons in magnetic field, a formula relating N_e and T_e with B was derived. This formula involves mirror-ratio R_m, electronic temperature in the absence of field T_{e1}, ion temperature T_i, linear-dimension of magnetic field l, and argon gas flux Q as parameters. Qualitative agreement with the measurement was obtained by the equation. This agreement was improved by varying the flux distribution and approximating to the model. In flowing plasma, magnetic mirror effect is dominant and makes it difficult to detect the anomalous diffusion in magnetic field, as observed in positive column plasma, by density measurement. (NSA of Japan)

39451 DOPPLER BROADENING OF SPECTRAL LINES OF IONS IN STOCHASTIC VARYING FIELDS IN A PLASMA. Lifshits, E. V. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Theor. Fiz., 56: 1891-6(June 1969). (In Russian).

Doppler broadening of spectral lines of ions in stochastic varying fields in a plasma is analyzed theoretically. Relations are derived that define the shape of the spectral lines in those cases when displacement of the ions is due to drift in crossed electric fields, appearing on development of instability and in a magnetic field. Expressions are also derived in the more general case when ion motion can be described by the Langevin equation, and the fields acting on the ions are electric fields with a finite correlation time between their amplitudes. (auth)

39452 SPECTROSCOPIC INVESTIGATION OF AN ARGON ARC PLASMA. Bues, I.; Haag, T.; Richter, J. (Univ., Kiel). Astron. Astrophys., 2: 249-50(June 1969).

In the course of an investigation of a high-current well-stabilized argon arc, a great number of atomic constants was measured. These constants were about 200 transition probabilities of mostly weak Ar I lines from the transition arrays 4s–4p, 5p; 4p–5s, 6s, 7s, 8s, 9s; 4p–4d, 5d, 6d, 7d, and Stark effect parameters (broadening and shift) of nearly 70 Ar I lines. This extended material is compiled in a laboratory report, which is available in a limited number of copies. (auth)

39453 STUDY OF AN EXPANDING HYDROGEN PLASMA WITH A RAPID SCAN SPECTROMETER. Hill, R. A.; Banister, J. R. (Sandia Labs., Albuquerque, N. Mex.). J. Quant. Spectrosc. Radiative Transfer, 9: 1083-96(Aug. 1969).

The impulse tube, an electrical shock tube, may be used to generate a volume of plasma with a current pulse whose duration is less than the time required for the plasma to move from the electrode region. The plasma is accelerated outward by rarefaction waves which originate near the electrode edges and at the same time shocks are generated in the surrounding gas, whose progress can be discussed in terms of the Rankine–Hugoniot relations. The expansion of a nearly fully ionized hydrogen plasma in this device was studied by photographic techniques and by rapid-scan spectroscopy. A complete history of the electron density was inferred from the half-intensity width of Stark-broadened $H\beta$ line profiles, and the plasma temperature was determined from the $H\beta$-to-continuum ratio. Numerical integrations which invoked the conservation of electrons were used to obtain the motion of individual portions of the expanding plasma; this observed expansion was found to be in substantial agreement with that predicted by conventional shock tube theory. The measured values of the electron density and temperature also verified the adiabatic character of the plasma expansion. (auth) (UK)

39454 PLASMA DIAGNOSTICS WITH IONIZED BARIUM AND TUNABLE DYE LASERS. Dimock, D.; Hinnov, E.; Johnson, L. C. (Princeton Univ., N. J.). Phys. Fluids, 12: 1730-2(Aug. 1969).

Resonance fluorescence and optical pumping techniques using tunable dye lasers permit the measurement of density, ion temperature, electron temperature, and ion drifts, over a wide range of density in barium, or barium-doped plasmas. (auth)

39455 NEAR-SURFACE ELECTRON TEMPERATURE OF WEAKLY IONIZED PLASMA ACCORDING TO KINETIC THEORY. Chung, Paul M. (Univ. of Illinois, Chicago). Phys. Fluids, 12: 1623-34(Aug. 1969).

Properties of electrons near absorbing and emitting surfaces are studied for weakly ionized plasmas by analyzing the Boltzmann equation governing the electrons. For simplicity, it is assumed that the electric field intensity is given a priori. It is shown that there exists a "nonequilibrium absorption layer," near the surface, wherein the kinetic distribution of electrons is completely out of equilibrium for all values of the mean free path, when the surface is highly absorbent with small or no electron emission. This layer is responsible for the large electron temperature jump at the surface, and it governs the electron temperature profile through the continuum as well as the rarefied plasmas. From the analysis it is found that the simple surface boundary condition for the continuum electron energy equation previously employed by the present author is correct when there is no surface emission. A similar simple surface boundary condition is deduced for surfaces with given finite emission rates. (auth)

Kinetics (General)

39456 (SU-IPR-297) HIGH-FREQUENCY BEAM-PLASMA INTERACTION AT FINITE TEMPERATURES. Rognlien, T. D.; Seidl, M. (Stanford Univ., Calif. Inst. for Plasma Research). May 1969. Contract AT(04-3)-326. 5p. (CONF-690803-11). Dep. CFSTI.

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

It is shown theoretically that even a moderate plasma temperature significantly reduces the growth rate of the instabilities near cyclotron harmonics when $k_\perp$ is large. The transition from continuous to discontinuous spectrum is shown experimentally by varying the diameter of the electron beam. (M.O.W.)

39457 DRIFTS AND PURIFICATION OF A FAST PLASMA INJECTED INTO A DOUBLE BEND MAGNETIC FIELD. Colomes, J.; Veron, D. (EURATOM-CEA, Fontenay-aux-Roses, France). Phys. Fluids, 12: 1717-22(Aug. 1969).

Drifts of plasma moving in a curved magnetic field are studied experimentally. Depolarization currents of the plasma are measured directly and compared with the values deduced from the distribution of the ion density at a given time. The curvature drift is used to remove fast heavy impurities. The electric drift is used to separate the fast component from the slow component of the plasma puff. (auth)

39458 STRUCTURE OF SHOCK WAVES WITH NON-EQUILIBRIUM RADIATION AND IONIZATION. Nelson, H. F. (Univ. of Missouri, Rolla); Goulard, R. Phys. Fluids, 12: 1605-17(Aug. 1969).

The investigations of this study are concerned with: (1) the physical processes that occur in the precursor and in the non-equilibrium region behind a strong shock wave during its approach to equilibrium in an argonlike gas; (2) the influence of different atom–atom collisional rates in the relaxation region on the precursor; and (3) the cause of precursor ionization, which in this study has been assumed to be the photoionization of both the ground and excited states. The argonlike gas is regarded as a combination of two gases; one consisting of electrons and the other of atoms and ions. Temperature differences between the two gases affect both the approach to equilibrium behind the shock wave and the precursor. Just behind the shock wave, the electron gas is cold relative to the atom gas. Farther into the relaxation region, the electron temperature approaches that of the atom gas, and thermal equilibrium is reached. Shortly thereafter, ionizational equilibrium is reached, and the gas begins to cool by the emission of excited-state radiation until it reaches its final steady state. The precursor ionization depends directly on the ratio of radiative to convective energy; thus, decreasing the ambient pressure increases both the extent and magnitude of the precursor. Increasing the atom–atom cross section increases the precursor ionization; however, changing the atom–atom cross section does not affect the extent of the precursor. (auth)

Kinetics (Experimental)

Refer also to abstracts 39071 and 39881.

39459 (D-1-82-871) FAST BEAM-SWITCHING ELECTRON GUN FOR TRANSIENT BEAM–PLASMA INTERACTION STUDY. Morris, Glenn J. (Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.). June 1969. 16p.

An electron gun and deflection system used to study transient beam–plasma interactions is described. The gun produces a 1- or 2-mm-diameter beam which can be switched off or on in ~0.5 nsec. Two such guns used in a two-beam device can easily excite large-amplitude plasma oscillations. Measurements of damping in the time domain were made by measuring the damping rate of these oscillations following beam cutoff. (auth)

39460 (NP-17962, pp 18-21) DECAY OF A COLLISIONLESS PLASMA FLOW NEAR A CRITICAL DENSITY IN UHF-FIELD. Sergeichev, K. F. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). (CONF-690803-5).

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

The decay of the collisionless plasma flow ($\gamma_{ei} = 3 \times 10^5$ c/s) was studied while passing a plasma along the axis of a circular waveguide in which the H_{01}-mode was excited in the S-band. Density distribution measurements are described. (M.O.W.)

39461 (SC-T-69-1031) PLASMA CURRENTS IN ELECTRIC LIGHT ARCS DUE TO SELF-MAGNETIC COMPRESSION. Maecker, H. Translated by Marcel I. Weinreich (Sandia Labs., Albuquerque, N. Mex.), from excerpts of Z. Phys., 141: 198-207; 211-16(1955). 20p. Dep. CFSTI.

The high-amperage electric carbon arc serves to demonstrate the already-known cathode plasma flow by means of further experiments. The cause of the flow is to be sought in the compression of the plasma through its own magnetic field, which is particularly strong at the cathode focal point. The pressure in the center of the cathode, as calculated by the hydrodynamic theory of plasma, agrees with the manometrically measured pressure (≈100 mm WS). The same applies to the recoil shock (≈1 pond) which is caused by the plasma flow and which impinges on the cathode. Since the acceleration mechanism, operated by the self-consistent field, must be effective at each narrow place of the discharge, the column is constricted with a cooled Cu jet nozzle having a diameter of 2.5 mm. As was to be expected, the nozzle emits plasma jets, one of which collides with the cathode flow, thus forming a plasma disc. In accordance with the formation through a narrow place, the flow (jet) is very hot because of the high density of current, so that the current prefers the path leading through the highly conducting jet, keeping it hot against the heat conduction. Thus the bright core of the arc arises. (auth)

39462 PHENOMENOLOGY AND ENERGY BALANCE OF ARC CATHODES AT LOW PRESSURES AND HIGH CURRENT STRENGTHS. Huegel, H.; Kruelle, G. (Institut fuer Plasmadynamik, Stuttgart). Beitr. Plasmaphys., 9: 87-116(1969). (In German).

The behavior of an arc cathode in a coaxial gas stream was investigated experimentally in a pressure and current range of 15- to 120-mm Hg and 400 to 1000 A, respectively. Argon and hydrogen were used as ambient test gases. Isolated phenomena occurring during the short nonstationary ignition period are described. Stationary operation characterized by a diffused cathode attachment covering a relatively large area is more closely studied. Measurements of the extension of the arc attachment and the distribution of the cathode temperature are made and evaluated quantitatively. Average current densities in the attachment are presented, as functions of pressure and current, by empirical expressions. Using a quasi-one-dimensional approach, an interior energy balance of the cathode is set up and heat entering the cathode in the attachment region is calculated. Finally, under further simplifying assumptions, the cathode-drop voltage and the fraction of current carried by ions are estimated and the so-called Richardson constant is determined, assuming electron emission according to the Richardson–Schottky equation. All data discussed depend strongly, in general, on ambient pressure and current, and the type of gas has a substantial qualitative and quantitative influence. (auth)

39463 EXPERIMENTS ON COLLISIONLESS SHOCK WAVES IN PLASMAS. Yamanaka, C.; Nakai, S.; Sakagami, Y.; Yamanaka, T.; Izawa, Y.; Kasuya, K. (Osaka Univ.). Technol. Rep. Osaka Univ., 19: Nos. 853-75, 101-16(Mar. 1969).

Experimental observations of shock waves propagating through collisionless magnetized plasmas are described. To clarify the properties of collisionless shock waves, three different methods were used. They were the gun-drive method, the laser-produced plasma method and the method using a super-Alfvenic continuous flow of cesium plasma. The magnetic Mach number was changed from 1 to 4. Various diagnostic techniques were used to investigate the characteristics of shock waves. As a result, for example, sharp shock fronts appeared, the sharpest one of which was at the magnetic Mach number about 2. And the dissipative mechanism of two-stream instability was supposed to be a predominant process for shock formation in the experiments. (auth)

39464 CHARACTERISTICS OF PLASMAS GENERATED BY A HIGH-CURRENT ELECTRON BEAM. Saito, Ryuta; Yamamoto, Takayoshi; Akimune, Hideo; Suita, Tokuo (Osaka Univ.). Technol. Rep. Osaka Univ., 19: Nos. 853-75, 19-27(Mar. 1969).

The characteristics of the plasmas produced by the high-current electron beam in the magnetic mirror field (B_{max} = 2200 gauss, mirror ratio = 1.5 ~ 3) are described. The plasma suddenly becomes highly ionized (20 ~ 50% ionization) as in the usual beam–plasma experiments, though intermittently, at a certain gas pressure (for $H_2 \sim 2 \times 10^{-4}$ torr) and is continuously produced at the higher pressure in the present experiment. The mechanism of the high-density plasma production is related to the large-amplitude low-frequency oscillation (0.5 ~ 1 MHz). (auth)

39465 INTERACTION OF PERPENDICULARLY INJECTED ELECTRON BEAMS WITH PLASMAS IN MAGNETIC FIELD. Yamamoto, Takayoshi; Suita, Tokuo (Osaka Univ.). Technol. Rep. Osaka Univ., 19: Nos. 853-75, 11-18(Mar. 1969).

The ion cyclotron harmonic emissions are observed in the diffused hydrogen plasma into which an electron beam is injected normal to the external magnetic field. These emissions are attributed to the growing ion cyclotron harmonic waves resulting from the coupling between the Bernstein mode that exists in Maxwellian plasmas in the magnetic field and the hybrid wave that propagates perpendicularly to the magnetic field along the beam.

A simple approximation equation is introduced instead of the exact dispersion relation and the dependences of these waves on several parameters are investigated. Comparison with experimental results exhibits qualitative agreement. (auth)

39466 ABRUPT INTENSITY TRANSITIONS IN RF-GENERATED PLASMAS. Thornton, John A. (Telic Corp., Santa Monica, Calif.). J. Appl. Phys., 40: 3404-6(July 1969).

Experimental observations concerning nonlinear transitions involving order-of-magnitude increases in the visible luminosity, which have been observed in rf-generated plasmas in several geometries, are described. (M.O.W.)

39467 RADIATION LOSSES OF A HIGH DENSITY Z PINCH. Kaufmann, Michael (Institut fuer Plasmaphysik GmbH, Munich). Z. Phys., 225: 216-30(July 1969). (In German).

The radiative losses of a high-density z pinch ($n_e = 10^{19}$ cm^{-3}) were investigated experimentally. When the compressed column has a temperature of 10 eV, the radiative losses were determined by a special measuring method in which the vacuum uv radiation was resolved in time and recorded by means of an open photocell. This method also involved absolute, but time-integrated measurement of the radiation by means of a thermopile. It was possible to achieve a certain resolution of the radiation wavelength by filling a volume between the light source and the detectors with various absorbing gases in succession. It was found that the major part of the internal energy of the plasma was lost by radiation. (auth)

39468 SPECTRAL AND MICROWAVE STUDIES OF THE DECAY OF A HIGHLY IONIZED HYDROGEN PLASMA. Brand, G. F.; Heckenberg, N. R.; Watson-Munro, C. N. (Univ. of Sydney). Aust. J. Phys., 22: 337-44(June 1969).

The decay of an almost fully ionized hydrogen plasma immersed in a magnetic field of 1 tesla was investigated spectroscopically and with microwave interferometers at 35 and 120 GHz. It was found that the plasma decays approximately exponentially in time, and that the density–temperature relations in the contracting central column are adequately described in terms of the theoretical predictions of Bates, Kingston, and McWhirter down to densities of about 1×10^{19} m^{-3} and temperatures of 2000°K. Competing processes of axial and transverse diffusion have been shown to play no significant part in the decay of this plasma. (auth)

39469 NOISE RADIATION FROM A PLASMA AT ELECTROACOUSTIC RESONANCE FREQUENCIES. Lustig, C. D. (Sperry Rand Research Center, Sudbury, Mass.). J. Appl. Phys., 40: 3048-9(June 1969).

Electroacoustic (Tonks–Dattner) resonances in a bounded plasma provide a means of coupling strongly from an external circuit into the thermal motion of the electrons in the plasma. The noise coupled out of the plasma in this way was compared with electromagnetic noise radiation from the plasma, and good agreement was found between noise temperatures deduced from the two methods. (M.O.W.)

39470 ELECTRON LOSS PROCESSES IN AIR AFTERGLOWS. Dobrov, W. I.; MacDonald, A. D. (Lockheed Research Lab., Palo Alto, Calif.). Phys. Fluids, 12: 1618-22(Aug. 1969).

A modified microwave cavity technique was used to measure the decay rates of electron densities in air afterglows. Measurements of low-duty cycle or single discharges which were not affected by the discharge products of preceding events were obtained by monitoring the shifts of the resonant frequencies. Results of measurements in late afterglows show that one loss mechanism can be described by an effective ambipolar diffusion coefficient representing participation of two positive ions in the process; the ions being most likely O_4^+ and NO^+. The other loss mechanism is due to two-body attachment of electrons, the likely attaching specie being NO_2. The measurements on two different x-band cavities in the pressure range 0.1 to 10.0 torr for ambipolar diffusion yielded: $D_{a,eff}\,p = 122 \pm 18$ cm^2/sec torr and for attachment: $h_a\nu_1 = (4.9 \pm 0.15) \times 10^3$ sec^{-1} torr^{-1}. (auth)

39471 MEASUREMENT OF VELOCITY SPACE DIFFUSION USING THE PLASMA WAVE ECHO. Jensen, T. H.; Malmberg, J. H.; O'Neil, T. M. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Fluids, 12: 1728-30(Aug. 1969).

The diffusion of plasma electrons in velocity space was measured, using the plasma wave echo as an experimental tool. The measurements were made for velocity space diffusion due to noise impressed on the plasma and that due to background noise. (auth)

Kinetics (Theoretical)

Refer also to abstract 39455.

39472 HIGH-FREQUENCY SCATTERING FROM A CONDUCTING CYLINDER WITH AN INHOMOGENEOUS PLASMA SHEATH. Wong, William C.; Cheng, David K. (Syracuse Univ., N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-17: 208-15(Mar. 1969).

The high-frequency backscattering characteristics of an infinite conducting cylinder enveloped in a radially inhomogeneous plasma sheath are studied in detail. When the permittivity of the sheath has a general power-law dependence, $\epsilon(\rho) = \epsilon(\rho_0)(\rho/\rho_0)^p$, where ρ_0 is the outer radius of the sheath and p is any real number $\neq -2$, the wave function in the plasma is expressible in terms of Bessel functions of a fractional order. The slowly convergent series form of the backscattering coefficient is first recast into an integral by means of the Watson transformation, which is then asymptotically evaluated by the method of stationary phase. The mathematical result is conveniently interpreted in terms of geometrical optics by identifying the contributions due to the central ray and the trapped "interrupted" and "uninterrupted" rays. In contrast to the rather unpredictable and violent backscattering coefficient variations with frequency when a conducting cylinder is clad in a homogeneous plasma sleeve, the change in the coefficient for the same cylinder enveloped in a plasma sheath with a power-law radial inhomogeneity is much more smooth and, in most cases, the approximate locations of the maximums and minimums can be predicted. Numerical results showing the dependence of the backscattering coefficient on the type of power-law inhomogeneity, sheath thickness and permittivity level are presented in graphical form. (auth)

39473 THEORETICAL ANALYSIS OF EFFECTS OF A MONATOMIC IMPURITY ON LOW-PRESSURE METAL ARC DISCHARGES IN A NOBLE GAS MATRIX. Hoyaux, Max F.; Sucov, Eugene W. (Westinghouse Research Labs., Pittsburgh). J. Appl. Phys., 40: 3237-46(July 1969).

The role of impurities in a low-pressure arc is theoretically investigated by use of a system of coupled rate equations. Some of the coefficients may be unknown; it is shown that by measuring a few parameters it is possible to obtain a set of equations at least equal in number to the number of unknown coefficients. The analysis is then particularized to the case when the introduction of the additive results in a perturbation sufficiently small that a linear treatment is applicable. This results in a system of seven linear equations, the left-hand side of which is obtained by adding seven terms, each a product of a known coefficient times perturbation on a certain plasma parameter (population of an excited level, electron density, electric field, etc.) whereas the right-hand side is linear in the pressure of the additive, the coefficient depending upon the characteristic properties of the additive. (auth)

39474 EFFECT OF INELASTIC COLLISIONS ON TRANSPORT PROPERTIES AND SHOCK STRUCTURE IN HIGH-TEMPERATURE GASES. Devanathan, C. (Imperial Coll. of Science and Tech., London). Proc. Roy. Soc. (London), Ser. A, 311: 291-308(July 8, 1969).

The behaviour of gases at moderately high temperatures, of the order of 10^4 K, undergoing inelastic collisions and affected by radiation, is studied by means of a modified Boltzmann equation. In the calculations, suitable inelastic collision cross sections agreeing well with experimental results for argon are used. The non-Maxwellian distribution arising out of these processes is obtained and, following the Chapman–Enskog–Hilbert procedure, the non-uniform state of such a gas is studied. The behaviour of viscosity, thermal conductivity and diffusivity is analysed. This analysis is applied to a one-dimensional normal shock. It is found that these inelastic processes considerably thicken the shock and, though there is only a weak "precursor" effect, the tail behind the shock is extended. The density and temperature profiles are obtained. (auth) (UK)

39475 THEORY OF MOTION OF CHARGED PARTICLES IN CONSTANT-DIRECTION MAGNETIC FIELDS WITH EXPONENTIAL DEPENDENCE ON TIME. III. GENERAL SWITCHING PROCESSES. Koch, Eckhard (Statistiche Physik, Leipzig). Beitr. Plasmaphys., 9: 141-55(1969). (In German).

The motion of a charged particle in a magnetic field is calculated for the following case: the spatially homogeneous magnetic field having a constant direction is a superposition of a field constant in time and one decreasing exponentially in time. The influence of the electric field induced by the time-dependent magnetic field and a friction force proportional to the particle velocity is taken into account. The higher transcendental functions appearing in the exact solutions are approximated in various ways, depending on the parameters. In this manner, approximate formulas of a very simple form are obtained for position, velocity, kinetic energy and magnetic moment of the parti-

cle, and the domain of validity of these formulas is determined. The particle orbits are classified, and their dependence on the initial values, parameters of the magnetic field, and magnitude of the friction force is studied. A comparison between the results and a rectangular variation of the field is given. It is shown that the electric field induced by the time-dependent magnetic field has an important influence on the particle motion. (auth)

39476 EFFECT OF LOW-FREQUENCY OSCILLATIONS ON ELECTRIC CONDUCTIVITY OF WEAKLY IONIZED PLASMA. Baimbetov, F. (Tbilissi State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 792-7(1969). (In Russian).

The effect of ion-acoustic oscillations on the electric conductivity and equilibrium distribution function of electrons of a weakly ionized plasma is investigated. (auth)

39477 EFFECT OF ION-ACOUSTIC OSCILLATIONS ON A WEAKLY IONIZED PLASMA. Baimbetov, F.; Tsintsadze, N. L. (Tbilissi State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 773-8(1969). (In Russian).

The effect of increasing ion-acoustic oscillations on the electric conductivity of the weakly ionized plasma is investigated. It is shown that at $t > (M/m)^{1/2}(v_{T_e}/v_0)\ 1/\gamma_{en}$ the electric conductivity of plasma is noticeably decreased. (auth)

39478 NONLINEAR THEORY OF PLASMA BEAM INTERACTIONS. II. THE ASYMPTOTIC BEHAVIOR OF THE SYSTEM. Leven, Ronald (Univ., Greifswald, Ger.). Beitr. Plasmaphys., 9: 165-78(1969). (In German).

The asymptotic behavior of an amplifying beam-plasma system for great distances x from the point where the beam enters the plasma is investigated on the basis of an expansion in powers of the electric field amplitude A_1. It is shown that a necessary condition for approaching a steady state with a constant wave amplitude is that the first $2\underline{N}-1$ derivations of the distribution function $f_\theta(u)$ at the point u_φ vanish if the approximation is to N-th order in A_1. Further, it is demonstrated that an approximation including the third power of A_1 involves the important physical effects as mode coupling and wave-amplitude saturation, and that fifth-order correction terms are unimportant, if the beam parameters are chosen so that the difference between beam and phase velocities is not too small. To illustrate this point some numerical examples are considered. (auth)

39479 PROPAGATION OF SHOCK WAVES IN INHOMOGENEOUS GASES. VI. OBLIQUE HYDROMAGNETIC SHOCK PROPAGATION. Yamazaki, Hatuo (Hokkaido Univ., Sapporo); Hashimoto, Yoshiaki; Ono, Yoro. Progr. Theor. Phys. (Kyoto), 41: 367-81(Feb. 1969).

The propagation of a hydromagnetic fast shock in a gravitational atmosphere permeated by a uniform magnetic field is studied by means of a generalized Chisnell method. It is shown that the fast shock propagating upwards always refracts away from the vertical, irrespective of the direction of the magnetic field, and the degree of refraction is higher when the ratio of the sound velocity to the Alfvén velocity along the magnetic field is smaller than unity. It is also shown that slow waves traveling upwards and downwards are generated in the fast-shock propagation through the atmosphere of declining density. The relation between these results and the heating of the solar corona is discussed. (auth)

39480 ELECTROSTATICAL SHIELDING IN CHARGED PLASMA. Rezikyan, A. M. (Inst. of Radiophysics and Electronics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 420-4(1968). (In Russian).

A general formula for quasi-neutral as well as for charged plasma is obtained for the definition of the radius of the electrical shielding in isothermal plasma. It is also shown that in the shielding sphere, depending on the direction of the electrical fields, one of the gases (electron or ion) is pressed inward to the sphere center, i.e., it will find itself in the electrostatic trap. (auth)

39481 NONLINEAR THEORY OF A WEAKLY TURBULENT PLASMA. Engelmann, F. (EURATOM-CNEN, Frascati, Italy); Zampaglione, V. Nuovo Cim., 62B: 43-68(July 11, 1969).

The evolution of a weakly turbulent, unstable, spatially uniform plasma is considered by means of a kinetic theory based on the Klimontovich equation for a single species of interacting particles. The usual expansion in powers of the amplitude of the electric field is used. This leads to a quasi-linear analysis in which the effects of the discreteness of matter are explicitly taken into account. A pair of coupled equations for the one-particle distribution function and the field fluctuations is deduced. In the special case of small growth rates, the latter is transformed into an equation for the spectrum of the fluctuating energy density. The results are compared with those of previous treatments. (auth)

39482 COLLISIONAL-RADIATIVE IONIZATION AND RECOMBINATION COEFFICIENTS FOR QUASI-STATIONARY HOMOGENEOUS HYDROGEN AND HYDROGENIC ION PLASMAS. Drawin, H. W. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Z. Phys., 225: 470-82(1969).

The recombination and ionization coefficients were recalculated on the basis of the collisional-radiative model. The numerical results obtained deviate from those published by Bates, Kingston, and McWhirter. The deviations reach a factor of about four for the recombination and a factor ten for the ionization coefficients. The smallest deviations occur in the recombination coefficients when the plasma is assumed to be optically thin in all transitions. The conditions for the applicability of the collisional-radiative model are discussed. (auth)

39483 INFLUENCE OF ATOM-ATOM COLLISIONS ON THE COLLISIONAL-RADIATIVE IONIZATION AND RECOMBINATION COEFFICIENTS OF HYDROGEN PLASMAS. Drawin, H. W. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Z. Phys., 225: 483-93(1969).

The collisional-radiative recombination and ionization coefficients were calculated for hydrogen plasmas of low ionization degree. The method consists in solving a coupled system of rate equations, which not only accounts for the electronic but also for the atomic collision processes. (auth)

39484 SOLUTION OF THE EQUATION GOVERNING THE INITIAL DISTRIBUTION FUNCTION FOR ELECTRONS IN GASES IN THE CASE OF ELASTIC COLLISIONS AND CONSTANT FLIGHT-TIMES. Ballerio, R.; Bonalumi, R.; Cavalleri, G. (CISE, Milan). Energ. Nucl. (Milan), 16: 547-54(July 1969).

In a recent paper by Cavalleri and Sesta [Phys. Rev., 170: 286 (1968)], a new theory of the electron drift velocity was given by introducing the distribution function $f_0(c_0)$ of the velocities c_0 immediately after a collision (initial distribution function). In this paper a numerical solution of the equation governing $f_0(c_0)$ is given for the case of elastic collisions and constant times of flights. The initial distribution function turns out to be Maxwellian even in the case of very high electric fields. (A.G.W.)

39485 EFFECT OF CHARGED PARTICLE-NEUTRAL COLLISIONS ON COLLECTIVE THOMSON SCATTERING. Gorog, I. (Laboratorio Gas Ionizzati, Frascati, Italy. European Space Research Inst., Frascati, Italy). Phys. Fluids, 12: 1702-7(Aug. 1969).

The effect of charged particle-neutral collisions on the spectrum of electromagnetic radiation scattered by the free electrons in plasma is investigated. The calculations are restricted to the regime where $\lambda_e \gg k^{-1} > \lambda_D$, where λ_e is the mean free path for electron, k is the magnitude of the scattering k vector, and λ_D is the Debye length. The spectral density of the electron fluctuations is computed from the Vlasov equation with the aid of a relaxational collision model. The results thus obtained correspond to Salpeter's expressions with a finite damping constant. The effect of collisions with neutrals on the central ion peak is found to be small in most laser scattering experiments. The effect of collisions on the electron wings, however, is much stronger. Approximate analytical estimates and more accurate numerical evaluation of the scattering cross section suggest that electron-neutral collisions may enhance the scattering from the longitudinal electron waves. (auth)

39486 NUMERICAL SIMULATION OF AXISYMMETRIC, COLLISIONLESS, FINITE-β PLASMA. Dickman, D. O.; Morse, R. L.; Nielson, C. W. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 12: 1708-16(Aug. 1969).

A numerical simulation method for time-dependent, axisymmetric, collisionless, finite-β plasma is described and applied to mirror modes in θ pinches and to rotational and tearing modes in Astron. It is shown that the mirror modes cause an increase of axial thermal velocities and the long time development of a gross bumpy structure in the θ-pinch plasma. The Astron plasma layer first develops tearing modes in agreement with linear theory, but at later times the wavelength of this mode increases by coalescence until the plasma is completely reassembled. (auth)

39487 MODIFICATION OF THE QUASILINEAR THEORY BY THE SPONTANEOUS EMISSION OF PLASMA WAVES. Nunez, P.; Rand, S. (Univ. of California, San Diego, La Jolla). Phys. Fluids, 12: 1666-72(Aug. 1969).

The transfer of energy between an electron beam and longitudinal waves in a collisionless plasma has been studied. The quasi-linear theory, with the inclusion of the spontaneous emission of wave energy, is used. Numerical solutions of the resulting equations are obtained and compared with those of the quasi-linear theory. (auth)

39488 HIGHER-ORDER CORRECTIONS TO THE THEORY OF THE GUIDING CENTER PLASMA. Wilson, Gerald E. (Univ. of Wisconsin, Madison). Phys. Fluids, 12: 1673-83(Aug. 1969).

The theory of the guiding center plasma is extended to include previously neglected terms proportional to the particle mass-to-charge ratio m/e. To do this it is necessary to obtain a correspondingly accurate solution of the single-charged-particle equation of motion. Then, one may define a conservation equation for the time average particle motion or, equivalently, for guiding centers. This equation is combined with a macroscopic momentum equation through the use of a generalized Ohm's law. Adding Maxwell's equations, the result is a self-consistent set of higher-order equations describing the behavior of the guiding center plasma. These equations are then linearized in small perturbations about a uniform equilibrium configuration to obtain stability criteria. The results show that these criteria are the same as those of the lowest-order system. (auth)

39489 CONSTANTS OF THE LINEARIZED MOTION OF VLASOV PLASMAS. Felderhof, B. U. (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 12: 1684-90(Aug. 1969).

It is shown that the symmetry properties of a time-independent solution of the set of Vlasov's and Maxwell's equations naturally lead to constants of the motion of the linearized equations. The constants corresponding to invariance under translations in time and to invariance under spatial translations and rotations are explicitly obtained. (auth)

39490 LORENTZ MODEL AND TIME-DEPENDENT DIFFUSION. Huchital, D. A.; Hollinger, H. B.; Holt, E. H. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Fluids, 12: 1691-6(Aug. 1969).

The formalism required to treat the time-dependent diffusion of the light particles of a Lorentzian fluid from a given initial state is developed at the microscopic level in terms of an appropriate solution of the Boltzmann equation. Comparison is made with the results obtained from the alternative macroscopic approaches based on Fick's law and the telegrapher's equation. It is shown that the development via the Boltzmann equation leads to a microscopic telegrapher's equation. A solution is also presented for the case where a potential gradient is applied. (auth)

Production

39491 (NP-tr-1823) DISCHARGE AND MULTIPHOTON IONIZATION IN THE FOCUS OF POWERFUL LASERS. Rabinovich, M. S. Translated for Culham Lab., Abingdon, Eng., from pp 355-74 of Eighth International Conference on Ionization in Gases, Vienna, Austria, August 27-September 2, 1967. 31p. (CTO-610). Dep.

The physical results obtained in recent years during studies of the development of laser sparks and multiphoton ionization of atoms are reviewed. The processes taking place in laser sparks — the avalanche ionization of gases in a laser focus — are discussed. The basic features of laser sparks, determined by the focal length of the lens and power of the laser beam, are indicated. Theoretical studies aimed at explaining the role of the bound states and effect of the Coulomb field on the final state in multiphoton ionization of atoms are briefly discussed. Systematic studies carried out in the author's laboratory on ionization of xenon and krypton by photons of energy 1.18, 1.78, and 2.36 eV are reviewed. 51 references. (TSS)

39492 PLASMA PRODUCTION SYSTEM FROM A SINGLE SOLIDIFIED GAS PARTICLE BY MEANS OF GIANT LASER. Hirosawa, H. (Tokyo Univ.); Tanimoto, M. Denki Gakkai Zasshi, 89: 160-9(Jan. 1969). (In Japanese).

Basic requirements in the production of plasma from a solid particle by a giant laser are discussed, and a scheme satisfying these requirements is proposed. Three main steps of the scheme are examined: (i) controlled growth of the ice column of plasma material and holding and reshaping of the column; (ii) cutting a pellet from the column and dropping it; and (iii) timing the high-power pulse of the Q-switched laser on the falling pellet. The basic technique was established for each step. Plasma materials used in this experiment were CO_2 and Xe, solidified in a capillary by cooling with liquid nitrogen in a column 400 μ in diameter. A temperature gradient along the capillary was found essential to reproducible growth. Reshaping of a neck to 50 μ in diameter is effected by evaporation of the column inserted halfway into a guide tube. Cutting at the neck is achieved with a laser pulse of relatively small energy. Uncertainty of the plasma origin due to the fluctuation in the timing of giant laser pulse and in the initial velocity of the falling pellet is discussed. Strobophotographs of the falling ice pellet show negligible initial velocity after reshaping. (NSA of Japan)

39493 THEORY OF IONIZATION AND RECOMBINATION IN A LOW-TEMPERATURE PLASMA. Biberman, L. M.; Vorob'ev, V. S.; Yakubov, I. T. Zh. Eksp. Theor. Fiz., 56: 1992-2000 (June 1969). (In Russian).

Expressions for the recombination and ionization rates in a plasma of arbitrary composition are obtained on basis of the concept of the two processes being one of electron diffusion in discrete energy space. Electron–atom collisions and radiative processes are taken into account. The possible absence of Maxwellian energy distribution of free electrons is taken into account. Results of concrete calculations are presented and compared with the experiments. (auth)

Stability

Refer also to abstract 39516.

39494 (AEC-tr-7053) STABILITY OF INHOMOGENEOUS HOT PLASMA FLOW. Baikov, I. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated from report NP-17656. 16p. Dep. CFSTI.

An abstract for the original paper appeared previously in NSA 23: 3525. (M.O.W.)

39495 (ORNL-TM-2652) EXPLOSIVE PLASMA INSTABILITIES. Fukai, J.; Krishan, S.; Harris, E. G. (Oak Ridge National Lab., Tenn.). Aug. 1969. 8p. Dep. CFSTI.

The explosive instability caused by the nonlinear interaction of two positive energy waves and one negative energy wave and its stabilization by higher-order nonlinear effects is described. (auth)

39496 (UCRL-71636) SIMULATION OF PLASMA MICROINSTABILITIES WITH SUPERPARTICLE COMPUTER MODELS. Byers, Jack A. (California Univ., Livermore. Lawrence Radiation Lab.). July 18, 1969. 18p. (CONF-690706-1). Dep. CFSTI.

From Conference on Computational Physics, Culham, England.

The use of superparticle computer models to simulate modes of plasma instability that are due to the loss-cone nature of the particle velocity distribution common to magnetic mirror confinement is discussed. In general, one has to deal simultaneously with ion gyration motion perpendicular to B and electron motion along B, and ideally one would like to start from realistic equilibrium configurations with both density and magnetic field variations. An essential problem associated with the superparticle approach is the greatly enhanced noise due to the small number of particles per Debye length. For infinite-medium models, essentially noise-free starting conditions were created by loading the phase space in a precisely uniform way. For a $k_{||} = 0$ one-species mode, growth starting essentially from machine roundoff levels can be observed at precisely the linear Vlasov theory predictions up to the saturated level, many orders of magnitude above the starting point. A stable distribution will remain at roundoff level, with no tendency to establish a thermal fluctuation level. In addition, a nonlinear instability was observed. Also, other $k_{||} = 0$ unstable-velocity distributions were examined, such as the combination of a stable loss cone plus a small amount of cold ions. The aim is the simulation of the finite-geometry mirror machine problem with a two-species, two-dimensional model encompassing density and magnetic field variations, and with the attendant particle and wave reflection at the mirrors. One step now being taken to simulate finite-geometry effects is a one-species two-dimensional model to set up the ion bouncing motion between mirrors in a noise-free equilibrium. (auth)

39497 NONSTATIONARY PROPERTIES OF A MARGINALLY STABLE PLASMA. Hatori, Tadatsugu (Tokyo Univ.). Phys. Fluids, 12: 1652-60(Aug. 1969).

Temporal behavior of some physical quantities is investigated for the system of electron plasma and injected beam with fixed velocity distributions. The fluctuation of the electric field with the critical wave number k_0 (defined by $\gamma_{k_0} = 0$) grows secularly; the velocity diffusion coefficient for v_0 (defined by $\omega_{k_0} = k_0 \cdot v_0$) grows in proportion to log t; the rate of energy loss by the beam approaches the enhanced value as $t^{-\frac{1}{2}}$. (auth)

39498 CRITICAL β FROM STELLARATOR AND SCYLLAC EXPANSIONS. Grad, Harold; Weitzner, Harold (New York Univ., N. Y.). Phys. Fluids, 12: 1725-7(Aug. 1969).

Toroidal equilibria with helical windings were studied, using two scalings, low β and finite β. A transfer of stability (critical β) found by one expansion is automatically invisible using the other. New stable regions are found with each expansion. (auth)

Thermonuclear Processes

Refer also to abstract 38361.

39499 (UCRL-71500) CONTROLLED THERMONUCLEAR POWER. Werner, R. W.; Myers, B.; Lee, J. D.; Mohr, P. B.

(California Univ., Livermore. Lawrence Radiation Lab.). June 27, 1969. 13p. (CONF-690905-1). Dep. CFSTI.

From 4th Intersociety Energy Conversion Engineering Conference, Washington, D. C.

A review is given of the elements of controlled thermonuclear power, the physics of containing a hot plasma, and the variety of proposed machines usable for a reactor. A reference design for a power-producing reactor is discussed which uses a lithium blanket surrounding the hot plasma to absorb energy and allow regeneration of the tritium fuel consumed in the basic reaction. A magnet surrounds the lithium blanket to provide a field for containing the plasma. The energy produced proceeds through a thermal conversion cycle, although there is the potential for direct electrical conversion. (auth)

39500 HIGH FREQUENCY-ANALOGUE MODEL FOR MEASURING MAGNETIC FIELD DISTURBANCES IN A THETA-PINCH COIL. Hartz, F.; Junker, J.; Wolf, G. H. (Institut fuer Plasmaphysik, Munich). Z. Angew. Phys., 27: 109-13(June 1969). (In German).

A model experiment is described in which the magnetic field and field perturbations in a theta-pinch coil are measured. The magnetic field, which is produced by a generator (714 kHz), can be measured with an accuracy of 0.05% by means of an induction coil, (0.7 mm dia.). In a cylindrical coil, the perturbation of the field from a radial slot and a rectangular observation window is investigated. In a coil with periodically corrugated inner diameter the perturbation of the rotational symmetry is measured. The latter effect is due to the collector feed slot. The angular dependence of the field perturbation and the decrease with increasing distance from the collector feed slot are investigated. (auth)

Wave Phenomena

39501 (NP-17962, pp 8-11) INVESTIGATIONS OF THE ANOMALOUS ABSORPTION OF A HIGH POWER H_{11}-WAVE IN A CIRCULAR WAVEGUIDE BY A DENSE COLLISIONLESS PLASMA. Gekker, I. R.; Sizukhin, O. V. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). (CONF-690803-4).

From 9th International Conference of Phenomena in Ionized Gases, Bucharest, Romania.

The experiments were carried out in the Ramus-II installation; two regimes of operation were used. In the first regime, the linearly polarized traveling H_{11} wave was excited. The plasma stream was injected by a spark source from the end of a circular waveguide through a microwave dummy load. In the second regime, the dummy load was absent and the plasma was injected in the H_{11} standing wave directly through a metal grid, which occupied the full cross section of the waveguide. (M.O.W.)

39502 (SU-IPR-300) EXPERIMENTAL STUDY OF LOW-FREQUENCY HELICAL WAVES IN A DISCHARGE PLASMA. Duncan, A. J.; Forrest, J. R.; Crawford, F. W.; Self, S. A. (Stanford Univ., Calif. Inst. for Plasma Research). May 1969. Contract AT(04-3)-326. 5p. (CONF-690803-8). Dep. CFSTI.

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

Experimental results for the first helical mode of a low-pressure mercury-vapor discharge are compared with theoretical predictions. The onset of spatial growth in this mode at low magnetic fields (~30 gauss) is confirmed, and the relation between this mode and self-excited instabilities is discussed. (M.O.W.)

39503 (SU-IPR-301) IONIZATION AND DRIFT WAVES IN A DISCHARGE PLASMA. Duncan, A. J.; Forrest, J. R. (Stanford Univ., Calif. Inst. for Plasma Research). May 1969. Contract AT(04-3)-326. 5p. (CONF-690803-9). Dep. CFSTI.

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

The propagation of m = 0 symmetric modes on a 2-meter-long 1.25-cm-radius helium positive column in an axial magnetic field was studied. The existence of a backward ionization wave and a forward electron drift wave is discussed. A brief theoretical treatment is given. (M.O.W.)

39504 (SU-IPR-302) INTERACTION IN BOUNDED BEAM-PLASMA SYSTEMS. Self, S. A.; Crawford, F. W. (Stanford Univ., Calif. Inst. for Plasma Research). May 1969. Contract AT(04-3)-326. 5p. (CONF-690803-12). Dep. CFSTI.

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

Laplace's equation is used to describe surface waves in a bounded beam–plasma system. Dispersion relations were derived and analyzed for three different cases. (M.O.W.)

39505 (SU-IPR-303) NONLINEAR TRANSVERSE WAVE INTERACTIONS IN A COLD MAGNETOPLASMA. I. PARAMETRIC AMPLIFICATION ANALYSIS. Harker, K. J.; Crawford, F. W. (Stanford Univ., Calif. Inst. for Plasma Research). May 1969. Contract AT(04-3)-326. 5p. (CONF-690803-10). Dep. CFSTI.

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

Two cases of nonlinear interaction involving principal modes in a cold magnetoplasma are considered: (1) three transverse waves propagating in the extraordinary mode perpendicular to the static magnetic field, and (2) three right-hand circularly polarized transverse waves propagating almost parallel to the static magnetic field. (M.O.W.)

39506 (SU-IPR-304) NONLINEAR TRANSVERSE WAVE INTERACTIONS IN A COLD MAGNETOPLASMA. II. SYNCHRONISM AND GROWTH CHARACTERISTICS. Crawford, F. W.; Harker, K. J. (Stanford Univ., Calif. Inst. for Plasma Research). May 1969. Contract AT(04-3)-326. 5p. (CONF-690803-7). Dep. CFSTI.

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

In part I, expressions for wave growth due to nonlinear parametric amplification were presented. These were derived assuming that the synchronism conditions could be satisfied by the waves of interest. It is shown here that this is possible over certain parameter ranges. Computations are presented for the growth rate within these ranges. (M.O.W.)

39507 RADIATION THROUGH AN INHOMOGENEOUS PLASMA COVERING A GROUND PLANE. Casey, Kendall F. (Inst. of Tech., Dayton, Ohio). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-17: 250-1(Mar. 1969).

Electromagnetic radiation from a slot-excited ground plane covered by a plasma layer with exponentially decreasing electron density is considered. It is found that the far-field radiation pattern is simply related to that found for the case where the layer is absent. (auth)

39508 TRANSIENTS IN DISPERSIVE MEDIA. PART II. EXCITATION OF SPACE WAVES AND SURFACE WAVES IN A BOUNDED COLD MAGNETOPLASMA. Whitman, Gerald M.; Felsen, Leopold B. (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-17: 200-8(Mar. 1969).

Transient phenomena due to localized sources in a bounded dispersive medium are studied, with emphasis on the propagation of surface waves. To accommodate these features, the configuration of a magnetic line source parallel to the gyrotropic axis in a cold magnetoplasma is chosen, with a perfectly conducting plane providing the bounding surface. After a formulation of the solution in integral form, the asymptotic considerations in Part I of this paper are applied for calculation of the transient behavior of the incident-, reflected-, and surface-wave constituents. Properties of these source-excited waves are discussed and compared with the corresponding response to plane-wave excitation. By comparison with an exact solution, some observations are made concerning the accuracy of the asymptotic approximations. (auth)

39509 NONLINEAR INTERACTION BETWEEN EXTRAORDINARY WAVES IN A COLD PLASMA. Harker, K. J.; Crawford, F. W. (Stanford Univ., Calif.). J. Appl. Phys., 40: 3247-56(July 1969).

An analysis was made of nonlinear interaction between extraordinary waves propagating perpendicular to the static magnetic field in a cold homogeneous magnetoplasma. It is first shown that the synchronism conditions for wave/wave interaction can be met over wide ranges of parameters. A theory of the interaction based on cold plasma theory is then described which yields a closed-form solution for signal growth by the mechanism of parametric amplification. Numerical solutions are presented for the growth rate, and associated frequencies and wavenumbers, over a range of magnetoplasma parameters. The relevance of these results to laboratory and space plasma experimentation, and to verification of the theory, is discussed. (auth)

39510 ELECTROMAGNETIC WAVES IN A COMPRESSIBLE PLASMA WITH A HOMOGENEOUS DRIFT VELOCITY AND MAGNETIC FIELD. Edenhofer, P. (Technische Hochschule, Munich). Z. Angew. Phys., 27: 114-23(June 1969). (In German).

The propagation of plane electromagnetic waves in an unbounded compressible plasma subject to a drift velocity and a magnetic field, both constant with respect to space and time, is studied. An investigation of the plasma's continuity conditions at boundary surfaces shows that eight field amplitudes can be prescribed. In accordance with this, a dispersion equation of eighth order is derived from a linear, homogeneous system of equations for the current density in the plasma. If the direction of the drift velocity and the direction of the magnetic field are parallel to the direction of

propagation, one finds two modes traveling as longitudinal waves and six modes propagating as transverse waves. For certain conditions, there are waves whose amplitudes decrease or increase exponentially along the direction of propagation. The propagation properties of the longitudinal modes strongly depend on whether the drift velocity is greater or less than the sound velocity of the plasma. The transverse waves include only four modes, if the drift velocity has no longitudinal component. In the general case of an arbitrarily directed drift velocity and magnetic field, it is shown that the eight existing modes propagate as waves of the mixed longitudinal–transverse type. (auth)

39511 ONE-DIMENSIONAL ACOUSTIC WAVE PROPAGATION IN A PLASMA FLUID IN THE NEAR FIELD OF AN ELECTRICAL DISTURBANCE. Broadbent, E. G. (Royal Aircraft Establishment, Farnborough, Eng.). Proc. Roy. Soc. (London), Ser. A, 311: 211-43(July 8, 1969).

The plasma is treated as a two-fluid system and methods are given for solving the near-field one-dimensional wave problem with an electrical source. A Laplace transform in time is taken, and in space either a Fourier transform is used (the first method) or the equations are written in difference form (the second method). The second method is more cumbersome but more general. Inversion of the Laplace transform requires the evaluation of the spectrum of a small matrix, or set of such matrices, in the first method, and of a large matrix (which may however sometimes be reduced into the spectrum of a set of small matrices) in the second method. An example of the first method is given. It is shown how steady gradients or steady electric currents can be taken account of, and some examination of wave stability is given. (auth) (UK)

39512 ELECTRON-MEDIATED INTERACTION BETWEEN AN ELECTRON PLASMA WAVE AND AN ION PLASMA WAVE IN A PLASMA. Kurasawa, Takasi (Electrotechnical Lab., Tokyo). Denki Shikensho Iho, 33: 254-8(Feb. 1969).

The growth of an ion wave with wavelength smaller than the electron Debye length, due to the electron-damped interaction between an electron plasma wave and an ion plasma wave, is discussed. The growth rate is obtained for the cases when the momentum distribution functions of electrons are Maxwellian and shifted Maxwellian. (auth)

39513 NONLINEAR INTERACTION OF A PLANE ELECTROMAGNETIC WAVE AND AN INHOMOGENEOUS PLASMA LAYER. Gil'denburg, V. B.; Kondrat'ev, I. G.; Markov, G. A. (Gorky Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 655-9 (1969). (In Russian).

Numerical solutions are presented of nonlinear problems on oblique incidence of a plane wave on an inhomogeneous plasma layer, the concentration of which is the local function of the amplitude of the electric field. The treatment is very similar to the quasi-static case considered earlier (Zh. Eksp. Teoret. Fiz., 46: 2156(1964)). (TSS) (auth)

39514 SOLITARY WAVE STRUCTURE IN A RAREFIED PLASMA. Zaitsev, V. V. (Gorky Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 779-91(1969). (In Russian).

The structure of solitary waves propagating in a collisionless plasma perpendicular to the magnetic field at an arbitrary value of the parameter $\alpha_e = H^2/4\pi n_e m_e c^2$, satisfying only the condition $v_{\perp}^2/c^2 \ll \alpha_e$, is described. The separation of charges in a solitary wave front and a possible relativistic velocity of their propagation are taken into account. In the laboratory coordinate system, where the unperturbed plasma is immovable, the dependence of the solitary wave width on α_e is of the nonmonotonous character. At first, the wave width is increased with the growth of α_e from the minimum value c/ω_{L_e} at $\alpha_e \ll 1$ up to the maximum value $c/2\omega_{L_i}$ at $\alpha_e = m_i/m_e$ and then it decreases because of the relativistic shortening. With $\alpha_e \geq m_i/m_e$ the dispersion effects caused by ions play the main part in formation of solitary wave front. The criteria for solitary-wave instability relative to excitation inside the front of plasma oscillations were obtained. (auth)

39515 EFFECTS OF COLLISIONS ON TEMPORAL PLASMA WAVE ECHOES. Ichikawa, Yoshi H.; Suzuki, Takehiko (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 41: 313-21(Feb. 1969).

Collisional effects on temporal plasma wave echo are examined on the basis of simple collision models, namely the relaxation-term model and the Fokker–Planck-type collision model. It is found that, besides the term varying as τ^3, predicted by Su and Oberman, the Fokker–Planck-type collision model also gives rise to a damping term varying as τ, where τ is the time interval between the two excitation pulses. The condition of observing the plasma wave echoes is $\gamma_L \tau > 1 \gg \beta\tau$, where γ_L is the imaginary part of the Landau zero point of the dielectric function and β the effective collision frequency. Under this condition, it is confirmed that the collisional damping of the plasma wave echoes varies as τ^3 (auth)

39516 LOW-FREQUENCY, ELECTROSTATIC OSCILLATIONS OF A TENUOUS, HOT E LAYER. D'Ambrogio, Enos; Nocentini, Aldo (Univ., Trieste, Italy). J. Appl. Phys., 40: 3121-6(July 1969).

The stability against low-frequency, electrostatic, flute-like oscillations of a tenuous, hot, plane layer of charged particles embedded in a uniform and constant magnetic field is considered. It is shown that finite Larmor radius effects do not modify essentially the diocotron modes. It is also shown that a layer of particles whose guiding centers are located on a thin (with respect to the thickness of the layer) sheet around the midplane of the layer, is unstable: more precisely it has, for long (with respect to the thickness of the layer) waves, the same dispersion relation which holds for the diocotron modes. This strongly supports the conclusion that the diocotron instability of a charged, tenuous, plane layer is essentially independent from its kinetic structure. (auth)

39517 INTERACTION BETWEEN LANGMUIR AND ACOUSTIC WAVES IN A TURBULENT PLASMA. Makhan'kov, V. G.; Tsytovich, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Theor. Fiz., 56: 1872-80(June 1969). (In Russian).

Interaction between plasma and hydrodynamic (acoustic) turbulences is considered. It is shown that such an interaction is of a decay-type for stationary and sufficiently broad spectra of intense Langmuir waves. (auth)

39518 DYNAMICS OF ELECTROACOUSTIC WAVES IN A LIQUID AND PLASMA. Gurovich, V. Ts.; Karpman, V. I. (Novosibirsk State Univ., USSR). Zh. Eksp. Theor. Fiz., 56: 1952-67(June 1969). (In Russian).

Wave processes are investigated by taking into account striction effects in a high-frequency electromagnetic field. The development of modulation instability of a plane electromagnetic wave due to interaction between the radiation and density disturbances is considered for liquids with a positive dielectric permeability. Transfer of electromagnetic radiation by sound disturbances in a plasma with negative dielectric permeability is also considered. (auth)

39519 RESONANT SCATTERING OF CYCLOTRON HARMONIC PLASMA WAVES. Porkolab, M.; Chang, R. P. H. (Princeton Univ., N. J.). Phys. Fluids, 12: 1697-1702(Aug. 1969).

Experimental results are presented which show that resonant mode coupling can be the dominant process in the scattering of cyclotron harmonic waves (or Bernstein modes). The important and new feature of the present work is that, in addition to confirming the frequency (energy) conservation relation $\omega_1 + \omega_2 = \omega_3$, the wavenumber (momentum) conservation relation $k_1 + k_2 = k_3$ is also shown to be satisfied in accord with the requirements of resonant mode coupling [where $\omega_1(k_1)$ and $\omega_2(k_2)$ refer to the incident waves and $\omega_3(k_3)$ to the product wave]. Since all three waves participating in the scattering process are cyclotron harmonic waves, the present work provides an important technique for studying the symmetry relations which govern wave–wave scattering processes in a magnetic field. (auth)

39520 SOLITARY WAVES IN A WARM COLLISION-FREE PLASMA. Krall, Nicholas A. (Univ. of Maryland, College Park). Phys. Fluids, 12: 1661-5(Aug. 1969).

The effect of finite temperature on the width of a magnetic solitary wave is calculated by expanding the Vlasov equation. The calculation is valid when this width exceeds the ion gyroradius but is less than the electron gyroradius. (auth)

39521 PROPAGATION OF COHERENT MAGNETOHYDRODYNAMIC WAVES. Liu, C. H. (Univ. of Illinois, Urbana). Phys. Fluids, 12: 1642-8(Aug. 1969).

The propagation properties of coherent magnetohydrodynamic waves in the presence of plasma density fluctuations are investigated. A perturbation technique borrowed from quantum field theory (renormalization procedure) is used to solve the stochastic wave equation. Effective propagation and attenuation constants are derived for propagation of plane coherent magnetohydrodynamic waves. It is found that, in general, the phase velocity will be less than the Alfvén velocity and there will be attenuation (or damping) of the waves due to the random mixing of phase. (auth)

39522 ANOMALOUS RESISTIVITY FROM DRIFT WAVES IN A MAGNETOPLASMA SHOCK WAVE. Woods, L. C. (Univ. of Texas, Austin). Phys. Fluids, 12: 1635-41(Aug. 1969).

The source of the anomalous resistivity that broadens shock fronts in a near-collisionless plasma is attributed to the drift-

wave instability driven by the strong electron temperature gradients in the front. Whistler-type waves propagating through the electrons in the plane of the shock front are treated by the fluid equations, with the ions kept unperturbed. The fastest growing unstable waves are found to propagate normal to the magnetic field, for which case the whistlers degenerate to convected waves. Resistivity is introduced such that it exactly cancels the growth rate due to the gradients, and the calculation is made self-consistent by using this resistivity to deduce the magnitude of the gradient. The main results are simple formulas for the anomalous collision frequency and the resistive shock thickness λ_η. It is found that $\lambda_\eta \simeq (T_{e2}/m_e v_1)^{1/4} (c/\omega_{pe})$, where the subscripts 1 and 2 refer to conditions upstream and downstream of the shock, and v is the component of plasma velocity normal to the stationary shock. This result is found to be in reasonable agreement with the few available experimental results. (auth)

Shielding

Refer also to abstracts 38151, 38299, 40091, and 40314.

39523 (CONF-690401-, pp 676-85) COHORT-II: A MONTE CARLO GENERAL PURPOSE SHIELDING COMPUTER CODE. Soffer, Leonard; Clemons, Lester C. Jr. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center).

The COHORT code has been greatly reworked and modernized. It has been integrated into a single package with more flexible geometry and biasing. The basic mechanics of the code have been checked out for several problems, and it is presently operable on the IBM-7094. (auth)

39524 RADIATION SHIELDING INFORMATION CENTER: A TECHNICAL INFORMATION SERVICE FOR NUCLEAR ENGINEERS. Trubey, D. K. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Design, 9: 392-5(Apr. 1969).

The Radiation Shielding Information Center (RSIC) at Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA, is a technical institute serving the international scientific community. It serves those engaged in research and development for the design of shields that provide protection from biological and physical damage due to penetrating, ionizing radiation. The Center is sponsored by the United States Atomic Energy Commission (USAEC) under contract with the Union Carbide Corporation and is also supported by the National Aeronautics and Space Administration (NASA) and the Defense Atomic Support Agency (DASA). In serving the interests of these agencies, RSIC is concerned with the shielding of radiation from nuclear reactors, nuclear weapons, radioisotopes, accelerators, and radiation present in space. (auth)

39525 SEMIGROUPS GENERATED BY THE BOLTZMANN OPERATOR. Hejtmanek, H. (Oesterreichische Hochschule, Vienna). Nukleonik, 12: 145-53(May 1969).

The linear Boltzmann operator is the sum of a partial differential operator of first order and the bounded collision operator. It is shown that sufficient conditions are satisfied that all operators are infinitesimal generators of a semigroup. For computational purposes the approximating discrete semigroup is studied and two examples of calculations are presented: the slowing down of neutrons in graphite and the multiple scattering of electrons by nuclear Coulomb interaction alone in an aluminum foil. 16 references. (auth)

39526 ENERGY DISTRIBUTION OF FAST NEUTRONS OUTSIDE REACTOR SHIELDS. Veselkin, A. P.; Egorov, Yu. A.; Orlov, Yu. V.; Pankrat'ev, Yu. V. At. Energ. (USSR), 26: 523-9(June 1969). (In Russian).

Some published data and the results of recent investigations on energy distribution of reactor fast neutrons outside homogeneous shields from hydrogenous, heavy and intermediate materials are generalized. Homogeneous metal–hydrogenous multilayer shields are also included. Results are presented for broad and pencil beams. General regularities of fast neutron spectrum distortion for various media are found. The influence of the two shielding materials and their layer thickness on fast neutron spectrum distortion is established. In particular, it was found that the fast-neutron-spectrum softening due to heavy material layers disappears completely in the presence of light material layers with the thickness equal to 3 to 4 relaxation lengths installed behind the heavy material layer. The further increase in the layer thickness of light material causes the spectrum to be formed only by this material. (auth)

39527 RESULTS OF DOSIMETRIC AND SHIELDING STUDIES WITH THE ARTIFICIAL EARTH SATELLITE KOSMOS-110. Akatov, V. P.; Kovalev, E. E.; Petrov, V. M.; Skvotsov, S. S.; Skuredin, V. P.; Smirennyi, L. N. Kosm. Issled., 7: 317-19 (Mar.-Apr. 1969). (In Russian).

Systematic dosimetric and shielding studies are needed to ensure the safety of the crew of a manned spaceship. Previous dosimetric measurements at heights of 200 to 400 km indicated that the dose per day of flight amounts to 10 to 30 mRad. The experiments were carried out on Kosmos 110 which had an apogee of 903 km, a perigee of 187 km, and an orbital inclination of 51.9°. The integral dose to which the two dogs on board were exposed during the 22-day-long flight, the doses behind various shields, and the spectra of linear energy losses were measured. The highest dose within the spacecraft was 14 Rad, the lowest 3.5 Rad. The total dose in the 40 to 140 MeV/cm linear energy loss level amounted to 1.25 Rad or 2.7 Rem. It was concluded that in spite of the lengthy stay in high-radiation areas, the radiation instruments were completely reliable. The mean dose did not exceed the permissible level for flights of less than one month. In the absence of solar flares, the radiation was due to protons from the radiation belt of the Earth. (TTT)

39528 RESOLUTION OF THE TRANSPORT EQUATION BY THE METHOD OF INVARIANT PLUNGING. Chapot, A. (Armees-Laboratoire Central de l'Armement, Arcueil, France). Radioprotection, 3: 265-91(1968). (In French).

The invariant plunging method is presented using two examples. The first is concerned with an evaluation of the neutron dose in a human body simulation. The second studies the formation and propagation of γ rays coming from the radiative capture of thermal neutrons in iron plates. Two auxiliary matrical algorithms are presented. (tr-auth)

Solid-State Physics

Refer also to abstracts 39592, 39626, and 39924.

Radiation Effects

Refer also to abstracts 37987, 38383, 38385, and 39416.

39529 (AD-680001) MATHEMATICAL SIMULATION OF THE EFFECTS OF IONIZING RADIATION ON SEMICONDUCTORS. Report No. Scientific-2. Kennedy, David P. (International Business Machines Corp., Hopewell Junction, N. Y. East Fishkill Lab.). Aug. 1968. Contract F19628-67-C-0116. 20p. (IBM-TR-22-731; AFCRL-68-0564). CFSTI.

A method is shown whereby differential capacitance measurements can be used to establish the impurity atom distribution in a semiconductor. Unlike previously published information on this topic, the method presented here is applicable to the measurement of semiconductor material containing a significant electrostatic charge. Illustrations are given of the differential capacitance inferred impurity profiles in the vicinity of abrupt and linearly-graded high-low junctions. (auth) (USGRDR)

39530 SEEBECK EFFECT IN α-Nb_2O_5 NEAR STOICHIOMETRY. Jesse, Kenneth E. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Appl. Phys., 40: 3386-9(July 1969).

The Seebeck coefficient, thermoelectric power Q, was measured in ceramic α-Nb_2O_5 with respect to platinum over a range of temperature of 700 to 1400°C and a range of ambient oxygen partial pressure of 1.0×10^{-6} atm. The data are interpreted on the basis of electrons moving in a narrow conduction band. (auth)

39531 TRANSIENT HIGH-ENERGY RADIATION-INDUCED FREE-CARRIER ABSORPTION IN SILICON. Peffley, W. M. (Hughes Aircraft Co., Fullerton, Calif.). J. Appl. Phys., 40: 3416-17(July 1969).

The time-dependent free-carrier absorption induced in silicon by pulsed 10-MeV electrons was studied. In contrast to previous investigations, carriers were generated at these energies throughout the bulk of the irradiated material; also, the free-carrier lifetime was appreciably greater than the duration of the radiation pulse. (M.O.W.)

39532 INFRARED ABSORPTION IN NEUTRON-IRRADIATED GaAs. Burkig, V. C.; McNichols, J. L.; Ginell, W. S. (McDonnell Douglas Astronautics Co., Santa Monica, Calif.). J. Appl. Phys., 40: 3268-73(July 1969).

The effect of fast-neutron irradiation on infrared attenuation in single-crystal GaAs was investigated. Both n- and p-type materials of several dopant concentrations were exposed to seven fluences of fast neutrons (>10 keV) from 5×10^{14} to 1.5×10^{18} neutrons/cm^2. Infrared transmission was measured before and after exposure. At low fluences, the free-carrier absorption of all samples was reduced by neutron irradiation. At the higher neutron fluences, an absorption process which showed no structure and varied approximately as the square of the photon energy was observed to dominate the free-carrier absorption. This absorption increased linearly with fast neutron fluence and was the same

for all samples studied independent of impurity type and initial concentration. The results are in agreement with a neutron-produced spike absorption mechanism proposed by McNichols and Ginell. (auth)

39533 LOCALIZED VIBRATIONAL MODES IN ELECTRON-IRRADIATED GaAs:Si. Spitzer, W. G. (Univ. of Southern California, Los Angeles); Kahan, A.; Bouthillette, L. J. Appl. Phys., 40: 3398-3400(July 1969).

Samples of GaAs : Si were taken from ingots grown from a stoichiometric melt. They were n-type with carrier concentrations ranging from $7 \times 10^{17} \lesssim n \lesssim 5 \times 10^{18}$ cm^{-3}. The samples were irradiated with 1-MeV electrons (el) from a Dynamitron electron accelerator until there was no measurable infrared free-carrier absorption to $\nu \sim 340$ cm^{-1} wave number. During the irradiation the samples were mounted on a copper-cooling fixture and sprayed with liquid nitrogen. Infrared absorption versus frequency diagrams are given. (M.O.W.)

39534 INTERNAL FRICTION OF SINGLE CRYSTAL U_4O_9. Doi, H. (Mitsubishi Metal Mining Co., Ltd., Omiya City, Japan). J. Appl. Phys., 40: 3080-6(July 1969).

Measurements of internal friction and Young's modulus between −210° and 700°C have been carried out at frequencies 130 to 185 kHz on U_4O_9 single crystals. Two pronounced internal friction peaks were observed, one at 60° and the other at −175°C. The peak at the higher temperature seems to be due to a phase transition of U_4O_9. The factors affecting the peak suggest that it is not caused by a relaxation process. It is suggested that some cooperative movements of interstitial oxygen ions in some lattice planes cause such a transition. The peak at the lower temperature is due to a relaxation effect. A rough calculation of the activation energy gave 0.034 eV. In addition, the results of the electrical conductivity measurements at low temperatures (25° to 160°C) gave the activation energy of 0.057 eV, in an approximate agreement with the one derived from the internal friction measurements. This indicates that the relaxation process involves activated charge transfer between U^{5+} and U^{4+} ions (hopping motion of electronic holes). It is tentatively proposed that stress-induced ordering of a defect complex involving U^{5+} ion and some oxygen ion(s), which produces a ⟨111⟩ elastic distortion in the lattice, gives rise to the relaxation effect. (auth)

39535 X-RAY INVESTIGATION DATA FOR CRYSTALLINE STRUCTURE OF SILICON FORMED IN CERAMICS AT RADIOLYSIS. Belousov, V. M.; Konopleva, L. N. (Tomsk Inst. of Radioelectronics and Electron Tech., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 130-1(1969). (In Russian).

The crystalline structure of silicon formed in ceramics during radiolysis was studied using steatite ceramic irradiated with ^{60}Co γ rays with doses of 10^7 and 10^8 R, and one-component specimens prepared with pure silica irradiated with 10^5 and 10^8 R. Tabulated X-ray data comparing the structure of both specimens before and after irradiation revealed the same crystal structure of silicon in both specimens. (R.V.J.)

39536 INVESTIGATION OF THE RADIATION CHANGES IN ONE-COMPONENT SAMPLES FROM SiO_2, MgO, Al_2O_3, AND B_2O_3. Belousov, V. M.; Konopleva, L. N.; Tarasenko, V. N. (Tomsk Inst. of Radioelectronics and Electron Tech., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 128-30(1969). (In Russian).

One-component specimens of SiO_2, MgO, Al_2O_3, and B_2O_3 were irradiated with ^{60}Co γ-ray doses of 10^5, 10^6, 10^7, and 10^8 R. The SiO_2 specimen showed a visible darkening, while the rest of specimens never changed their color. Analysis of the data showed that the color change in the SiO_2 specimen was caused by silicon particles formed during radiolysis of the silica. (R.V.J.)

39537 RADIATION EFFECTS IN IONIC CRYSTALS DUE TO INCREASING OF THE IRRADIATION TEMPERATURE. Kozlov, Yu. F. (Tomsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 124-5(1969). (In Russian).

Ionic crystals of KCl + 0.1 mole % $CaCl_2$ and KCl + 0.1 mole % Na_2S irradiated with 9.7×10^{18} neutr/cm^2 doses at 50°C. Tabulated results show the influence of two-valent cations and anions on the loss of color and irregular distribution of defects across the specimen, initiated by simultaneous effects of irradiation and temperature. (R.V.J.)

39538 THE TRANSMISSION SPECTRA OF GALLIUM ARSENIDE IRRADIATED BY PROTONS POSSESSING ENERGY OF ~5 MeV. Red'ko, V. P.; Ramazanov, P. E.; Yamanovskii, V. M.; Pronin, V. N. Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 120-2 (1969). (In Russian).

Optical properties of n-type gallium arsenide with electron concentration of 8×10^{13} to 1×10^{14} cm^{-3}, (2 to 4) $\times 10^{16}$ cm^{-3}, and (1 to 3) $\times 10^{19}$ cm^{-3} under 5-MeV proton irradiation were studied; specimen thickness exceeded penetration depth (~100 μ) of the protons. Irradiation was carried out in a cyclotron at a flux of 1.9×10^{15} proton/cm^2 and repeated at 3.8×10^{15} proton/cm^2. The transmission spectra examined with an infrared spectrometer before and after irradiation showed variable effects depending on the initial electron concentration, irradiation dose, and temperature. A considerably reduced penetration was observed near the edge of self-absorption and a shift in the long-wavelength region was observed with the dose of 1.9×10^{15} proton/cm^2. The repeated dose of 3.8×10^{15} proton/cm^2 induced the shift further into the long-wavelength region, which in turn reduced the transmission zone. Isochronous annealing at 550°C restored the spectrum to the original form. (R.V.J.)

39539 THERMAL RELEASE OF KRYPTON FROM THIN LAYERS OF GOLD. Gautsch, O.; Wahl, H. (Joint Nuclear Research Centre, Ispra, Italy). Int. J. Appl. Radiat. Isotop., 20: 447-52(June 1969).

The release of Kr from thin layers of Au was investigated by thermal annealing of Kr-bombarded Au discs. Large fractions of the gas were released below 900°K within 200 min. The gas emission occurred with a spectrum of activation energies, and it was mainly controlled by about 30 kcal/mole for 1 keV of bombarding energy, and 50 kcal/mole for 5 keV and for 10 keV. The release behavior showed that temperature measurements with kryptonated Au samples are sufficiently reliable only for those temperatures which correspond to the ascending part of the spectrum. (auth)

39540 RADIATION DAMAGE IN SEMICONDUCTORS AND SEMICONDUCTOR COMPONENTS. Baeuerlein, Rudolf (Siemens Schuckertwerke AG, Erlangen, Ger.). pp 1-41 of Festkoerper Probleme. VIII. Madelung, O. (ed.). New York, Pergamon Publishing Co., 1968. (In German).

The current status of radiation damage in semiconducting materials and components is reviewed. Problems related to the mechanism of production of defects by bombardment with energetic particles, especially the displacement energy, are discussed in detail. Microstructure of radiation defects in silicon, which is known from electron spin resonance and optical absorption experiments, is dealt with. Vacancies created as primary defects move below room temperature and combine with impurity and doping atoms, and thereby form a new kind of defect center. In semiconductors primary and secondary defects are electrically active; therefore, many properties of material are changed by irradiation. In semiconducting components with pn junctions, radiation defects mainly form recombination centers, and this leads to a decrease of lifetime and diffusion length of minority carriers. In planar and MOS field-effect transistors, damage also is caused by ionization that creates a positive space charge in the silicon oxide layer and interface states between the silicon surface and the silicon oxide layer. Radiation defects anneal at elevated temperatures. The phenomena of recovery of irradiated semiconducting materials are various because new defect complexes are formed during the annealing process. 61 references. (auth)

39541 INVESTIGATION OF ION-IMPLANTED CRYSTALS BY MEANS OF DIRECTIONAL EFFECTS IN CHARGED-PARTICLE REACTION YIELDS. Boegh, E. (Univ. of Aarhus, Denmark). Proc. Roy. Soc. (London), Ser. A, 311: 35-46(June 24, 1969).

The method described allows simultaneous investigations of the sites of the implanted atoms and of the damage of the substrate structure caused by the implantation. It is based upon the orientation dependence of charged-particle reaction yields in single crystals. A short summary of the underlying theory is given, and the experimental procedure is discussed. The utility of the method is demonstrated in an investigation of implanted Fe and Si crystals. The results show a remarkable difference between Fe and Si as to the amount and distribution of the implanted ions and the damage. At a dose of 8×10^{13} 60-keV Sb ions/cm^2, Si was completely disordered in a region corresponding to the range distribution, and the implanted ions could not be assigned to well-defined sites. Fe was only moderately damaged after a dose of 2×10^{16} 150-keV Sn ions/cm^2 (which have about the same projected range in Fe as the 60 keV ions in Si), and ca 85% of the implanted ions were on lattice sites. This result provides a direct explanation of the difference between implanted metallic and nonmetallic Mössbauer samples. (auth) (UK)

39542 PHYSICAL STATE OF ION-IMPLANTED SOLIDS. Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Roy. Soc. (London), Ser. A, 311: 53-61 (June 24, 1969).

The destruction of the crystalline lattice during ion implantation is discussed in general terms together with its post-irradiation annealing. It is shown that the creation of mobile defects during implantation can give rise to an irradiation-enhanced diffusion which can, in some cases, dominate thermally activated diffusion. The expected state of implanted impurity atoms is discussed in

some detail, with special attention to the formation and stability of precipitate phases in an irradiation environment. (auth) (UK)

39543 TARGET PREPARATION. Whitton, J. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Proc. Roy. Soc. (London), Ser. A, 311: 63-73(June 24, 1969).

The requirements for the surface preparation of single crystals to be used in the measurement of heavy ion channeling, proton scattering, etc., processes, which depend on the ordered nature of the lattice, are much more stringent than those for the standard metallographic examination of surfaces. The various techniques of sectioning, grinding and polishing of single crystals are described. The type and depth of damage introduced as a consequence of these techniques is illustrated and it is shown how this damage may best be removed. The mounting of prepared targets in vacuum apparatus, in a manner suitable for measurement of channeling effects over a wide range of temperature, is described and illustration is made of the effect of disordered surfaces, due to oxidation or to ion bombardment, on the measured yield of the channeling processes. (auth) (UK)

39544 DISTRIBUTION OF CONDENSED DEFECT STRUCTURES FORMED IN ANNEALED BORON-IMPLANTED SILICON. Bicknell, R. W. (Allen Clark Research Centre, Towcester, Eng.). Proc. Roy. Soc. (London), Ser. A, 311: 75-8(June 24, 1969).

Experimental work is described on Si implanted with 10^{14} to 10^{16} B ions/cm^2 at energies of 25, 50, 75, and 100 keV, including the effect of annealing at 873° to 1073°K, which causes the implanted ions to occupy substitutional sites and form a "doped" surface layer for which the doping profile can be accurately controlled. The implanted layers were examined by electron microscopy and electron diffraction before, during, and after annealing, in order to study changes in crystal structure. The first visible change in structure with ion bombardment was the formation of a thin "amorphous" layer on the surface of the Si, the visibility and depth of this layer depending on ion dose and type of ion. It was shown by glancing-angle electron diffraction that the surface layer of the annealed material can contain stacking faults and twins. During annealing, many loop dislocations lying on {111} planes form in the bombarded layer, and in specimens implanted at room temperature, they are often accompanied by long straight-edge dislocations running in all the ⟨110⟩ directions. The loops were analyzed, and loops lying on the {111} planes were found to contain interstitial atoms. It was evident from micrographs obtained from the edges of thin taper sections that none of the loops occurred in the thinnest areas; the loop defects were confined to a stratum 100 to 250 nm below the surface, the majority lying in a band 100 to 150 nm below the surface. In specimens implanted at 573°K there was an absence of the long ⟨110⟩ dislocations, but there were many loops lying on {110} planes as well as {111} planes. It was shown that the loops on the {110} planes consisted of about equal numbers of interstitial and vacancy types, whereas those on {111} planes were still all of interstitial type. On annealing at higher temperatures the loops decreased in number and increased in size, but at 1073°K they stabilized in size and number. These results are discussed. The prehistory of the Si may have a strong influence on the types of defect. (UK)

39545 USE OF ISOTOPE SEPARATORS FOR ION IMPLANTATION. Freeman, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Roy. Soc. (London), Ser. A, 311: 123-30(June 24, 1969).

The use of experimental electromagnetic isotope separators in the study of ion–solid interactions is described. More recently they have proved particularly useful in the ion doping of semiconductors. The use of the separator for hyperfine interaction studies combines the stringent but largely disparate requirements of the nuclear spectroscopy and the ion implantation applications. The advantages and the limitations of this method of sample preparation are considered in some detail and briefly compared with other possible techniques. (auth) (UK)

39546 CHARGED F-AGGREGATE CENTERS IN NaCl. Schneider, Irwin; Bailey, C. Edward (Naval Research Lab., Washington, D. C.). Solid State Commun., 7: 657-60(May 1969).

Data are presented for 2-MeV-electron-irradiated NaCl which identify the absorption and emission bands of the M^+, R^+, and M' centers. The transitions for the M^+ and R^+ centers differ from those formerly attributed to these defects. (auth) (UK)

39547 TEMPERATURE DEPENDENCE OF THE DECAY TIME AND QUANTUM EFFICIENCY OF F-CENTER LUMINESCENCE IN KCl. Stiles, L. F. Jr.; Fontana, M. P.; Fitchen, D. B. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-3464. Solid State Commun., 7: 681-3(May 1969). (NYO–3464-16).

Improved measurements of τ and η in the range 4.2 to 170°K revealed a temperature dependence of the radiative lifetime, $\tau_R = \tau/\eta$, consistent with recent Stark effect measurements, in x-irradiated KCl. (auth) (UK)

39548 PARAMAGNETIC RESONANCE OF AN N CENTRE IN CALCIUM OXIDE. Bessent, R. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., C (London), 2: 1101-2(June 1969).

A paramagnetic point defect was observed in high-purity single crystals of calcium oxide after neutron irradiation. The electron paramagnetic resonance spectrum is described by an orthorhombic g tensor with principal axes approximately along [211]-, [111]-, and [110]-type directions and with $S = \frac{1}{2}$. It is suggested that the defect may be an F-aggregate center similar to Pick's N_1 center. (auth) (UK)

39549 RADIATION EFFECTS ON Si MONOCRYSTALS. Abdullaeva, D. M. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 65-6(1968). (In Russian).

The electric resistance anisotropy induced by irradiation was studied using specimens of n-Si crystals irradiated in a reactor along the crystallographic axes (111), (110), and (100). Bombardment along (110) formed three-dimensional complexes, and along (111) two-dimensional. Considering that conduction electron scattering on three-dimensional complexes is higher than on two-dimensional, the maximum conductivity was observed along (110) and the minimum along (111). (R.V.J.)

39550 CREATION OF F CENTERS IN LITHIUM FLUORIDE BETWEEN 77° AND 600°K AND THEIR INTERPRETATION BY A RECOMBINATION MODEL OF INTERSTITIAL-VACANCIES. Durand, P.; Farge, Y.; Lambert, M. (Faculte des Sciences, Orsay, France). J. Phys. Chem. Solids, 30: 1353-74(June 1969).

In pure LiF crystals the number of F centers generated by x irradiation between 200 and 600°K is proportional to the square root of the irradiation time. At room temperature, for the same irradiation time, the number of F centers increases proportionately to the square root of the radiation intensity. At irradiation temperatures higher than 400°K, a fraction of F centers clusters to form large agglomerates observable by small-angle x-ray scattering. It is assumed that the radiation creates KI Frenkel pairs per unit time (I being the radiation intensity) and that interstitials thus created diffuse towards F centers or towards traps which are assumed to be agglomerates of interstitials: calculation leads to a generation law of F centers proportional to $(It)^{\frac{1}{2}}$, in good agreement with experimental results. This model is verified by studying the disappearance of M centers by x irradiation below 250°K; such a bleaching occurs through trapping of free interstitials by these centers. (auth) (UK)

39551 INTERPRETATION OF THE CREATION OF F CENTERS BY IONIZING RADIATION ABOVE 77°K BY A RECOMBINATION MODEL OF INTERSTITIALS AND VACANCIES. Farge, Y. (Faculte des Sciences, Orsay, France). J. Phys. Chem. Solids, 30: 1375-84(June 1969).

In pure samples the first stage of F-center creation by ionizing radiations is not observed. The creation of F centers is explained theoretically assuming that interstitials formed by the primary process diffuse towards F centers or toward traps which are large aggregates of interstitials. With this model, the saturation studied by Sonder and Templeton (1967) can also be explained. Addition of other traps (surfaces, dislocation lines, impurities) changes the theoretical creation curve and permits partial explanation of the first stage of F-center creation in alkali metal halides. (auth) (UK)

39552 ACTIVATION ENERGY FROM THERMOLUMINESCENCE AND PHOSPHORESCENCE OF $\alpha-Al_2O_3$. Van Tricht, J. B.; Van der Kraay, B. A. M. (Reactor Inst., Delft, Netherlands). J. Phys. Chem. Solids, 30: 1629-30(June 1969).

The activation energies derived from glow peaks show large discrepancies, which may be due in part to the assumption of one discrete trap depth instead of a contribution of different depths. It is suggested that the phosphorescence decay is less sensitive to such a distribution. Both phosphorescence and thermoluminescence in $\alpha-Al_2O_3$ activated by ^{60}Co-gamma radiation were investigated. (UK)

39553 ESR STUDY OF SIMULTANEOUS OPTICAL BLEACHING AND X IRRADIATION OF KCl. Piazza, R. E. (Emory Univ., Atlanta). J. Phys. Chem. Solids, 30: 1635(June 1969).

The experiment described corroborated results obtained by other techniques, and indicated the usefulness of the helical assembly as a tool in radiation damage research. (UK)

39554 CORRELATION BETWEEN "A" BAND AND ABSORPTION IN THE NIR IN NATURAL SiO_2 IRRADIATED BY ELECTRONS. Porreca, Flavio (Univ., Naples). Solid State Commun., 7: 961-4(July 1, 1969).

Electron irradiation of natural quartz produces correlated growth of "A" band (4000 Å) and changes in the ir peak at 2.86 μ

and 2.95 μ. Thermal annealing restores the spectrum. A possible interpretation of this correlated effect is suggested on the basis of the "A" center model. (auth) (UK)

39555 SLOWING DOWN OF IONS. Lindhard, J. (Univ. of Aarhus, Denmark). Proc. Roy. Soc. (London), Ser. A, 311: 11-19(June 24, 1969).

The main concepts underlying slowing-down processes are discussed, together with levels of experimental accuracy. Aspects of interest in connection with measurements of hyperfine interactions are considered, and the so-called transient magnetic fields are discussed. Headings are as follows: general classification; protons; heavy ions; nuclear collisions; electronic stopping; and radiation damage. (UK)

39556 RANGE AND ENERGY LOSS OF IMPLANTED IONS. Dearnaley, G. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Roy. Soc. (London), Ser. A, 311: 21-33 (June 24, 1969).

It is stated that there are still important features concerning the mechanism of energy loss of charged particles in matter which are poorly understood. In sensitive experiments on range distributions of ^{24}Na, ^{42}K, ^{85}Kr and ^{133}Xe in amorphous Al_2O_3 (Jespersgard and Davies (1967)) good agreement was found with "universal" formulae for ion ranges and range straggling for energies up to ~100 keV, but at higher energies the observed ranges were consistently higher (by as much as 30% at 1 MeV). Other anomalies become apparent when the rate of energy loss is measured at constant velocity for different ions traveling through the same absorber. In experiments on hyperfine interactions using crystalline target specimens the ranges of ions can be significantly modified due to the array of scattering centers being ordered (channeling or "string" effect). In the present paper the more fundamental behavior of ions in single crystals is discussed, including experimental techniques for determination of distribution profiles of implanted ions. At Harwell use is made of anoding stripping, with both tracer and electrical conductivity measurement, to investigate the distribution of ions in crystals, as a function of ion energy, crystal temperature, and orientation. Consideration is given to the factors which control the rate of energy loss of ions in crystals, for the two cases of light and fast particles such as electrons, protons and α-particles of MeV energies, and that of slow and heavy ions. Experimental work supports a model in which a single process of electronic excitation is considered, of predominantly a collective type. (UK)

39557 STRUCTURE EFFECTS IN LOW-ENERGY ELECTRONIC STOPPING. Cheshire, I. M.; Dearnaley, G.; Poate, J. M. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Roy. Soc. (London), Ser. A, 311: 47-51(June 24, 1969).

Recent experiments have shown electronic stopping cross sections to have an oscillatory dependence on ionic atomic numbers with minima in the region of Li, Na and Cu. The amplitudes of the oscillations are enhanced when the ions are channeled. To explain these effects the Firsov theory of electronic stopping is modified by replacing the Thomas–Fermi atom with simple Hartree–Fock wave functions, thus allowing for the different ionic sizes. Theoretical predictions are made for the stopping cross sections of ions in amorphous carbon and of channeled ions in silicon. (auth) (UK)

39558 ION IMPLANTATION BY MEANS OF NUCLEAR REACTIONS. Grodzins, L. (Massachusetts Inst. of Tech., Cambridge). Proc. Roy. Soc. (London), Ser. A, 311: 79-110 (June 24, 1969).

A number of applications are discussed which utilize ion implantation following nuclear reactions. Nuclear reaction implantation has been used to produce Coulomb excited sources for Moessbauer studies of moments of rotational states in deformed nuclei; well-resolved hyperfine lines are usual, making a systematic study of nuclear moments possible. If single-line absorbers are used to study line width as a function of target and recoil parameters unique information may be obtained, and for such studies, heavy ion beams would appear most effective. Other applications include the measurement of the lifetimes of nuclear states, measurements of energy loss and ranges of recoiling ions, and the measurement of atomic effects on highly stripped ions. (UK)

39559 IMPLANTATION-PERTURBED ANGULAR CORRELATION EXPERIMENTS IN IRON AFTER INELASTIC PROTON SCATTERING. Murnick, D. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.); MacDonald, J. R.; Borchers, R. R.; Heestand, G.; Herskind, B. Proc. Roy. Soc. (London), Ser. A, 311: 111-18 (June 24, 1969).

Hyperfine interactions in iron metal were studied by the standard impact technique, populating the 0.847 MeV, 10.4 ps state of ^{56}Fe and the 1.408 MeV, 1.42 ps state of ^{54}Fe via the (p,p') nuclear reaction. In all cases the experiments yielded shifts of less than 0.005 Rad in the correlation pattern. The low results imply that the average hyperfine field in iron implanted into iron is less than 175 kg during the first 10 ps after implantation. The results are discussed in terms of possible radiation damage and transient field effects, and microscopic details of the impact process are considered. (auth) (UK)

39560 SOME NUCLEAR APPLICATIONS OF PERTURBED ANGULAR CORRELATIONS WITH HYPERFINE INTERACTIONS. Deutch, B. I. (Univ. of Aarhus, Denmark). Proc. Roy. Soc. (London), Ser. A, 311: 151-67(June 24, 1969).

Problems regarding perturbed angular correlation measurements utilizing the hyperfine interactions experienced by radioactive nuclei embedded in iron foil by use of isotope separators are discussed. The three main topics are: the magnetization of the foil, the magnetic time-dependent interaction from paramagnetic spin relaxation of rare earths in iron, and experiments involving electron cascades. (auth) (UK)

39561 CHANNELING OF MeV He^+ IONS IN TUNGSTEN AND OTHER CRYSTALS: AN INTERCOMPARISON OF RUTHERFORD SCATTERING AND OF CHARACTERISTIC L AND M X-RAY YIELDS. Davies, J. A.; Eriksson, L.; Johansson, N. G. E.; Mitchell, I. V. (Chalk River Nuclear Labs, Ontario). Phys. Rev., 181: 548-51(May 10, 1969).

Measurements of wide-angle (150°) scattering and of L and M x-ray yields in tungsten single crystals are reported as a function of crystallographic orientation with respect to an incident beam of 1.4-MeV helium ions. Comparison of these yields establishes both lower and upper limits for the minimum impact parameter (r_{min}) between a channeled ion and the tungsten-lattice atoms; these limits are consistent with Lindhard's estimate that $r_{min} \sim a$, the Thomas–Fermi screening distance (i.e., ~0.11 Å for He in W). A similar comparison between wide-angle scattering and x-ray yield curves is reported for several other lattice—Al, Si, GaP, GaSb, and UO_2; again the results are consistent with the predicted relationship: $r_{min} \sim a$. Anomalies in published orientation studies of K, L, and M x-ray yields are shown to be due to depth effects. (auth)

Physical Properties

Refer also to abstract 39440.

39562 (BNL–13822) TABLE OF ANTIFERROMAGNETIC MATERIALS STUDIED BY NEUTRON DIFFRACTION. Cox, D. E. (Brookhaven National Lab., Upton, N. Y.). June 1969. 91p. Dep. CFSTI.

This table was originally prepared for the forthcoming edition of the American Institute of Physics Handbook. It summarizes magnetic structural data reported in the literature up to about the end of 1968. It contains considerably more descriptive detail than the version finally adopted for the Handbook, in which limitations on space ultimately necessitated a much more concise format. 462 references. (TSS)

39563 LOW-TEMPERATURE ELECTRICAL RESISTIVITY OF PURE NIOBIUM. Webb, G. W. (Univ. of California, San Diego, La Jolla). Phys. Rev., 181: 1127-35(May 15, 1969).

The temperature dependence of the normal-state electrical resistivity of very pure niobium is reported here. The measurements were carried out in the temperature range from the superconducting transition (T_c = 9.25°K) to 300°K in zero magnetic field and from 2 to 22°K in a magnetic field strong enough to quench all superconductivity. The resistance-versus-temperature data were analyzed in terms of the possible scattering mechanisms likely to occur in niobium. To fit the data a single-band model was assumed. The best fit can be expressed as $\rho = (4.98 \pm 0.7) \times 10^{-8} + (0.077 \pm 3.0) \times 10^{-7}T^2 + (3.10 \pm 0.23) \times 10^{-7}[T^5J_5(\Theta/T)/7.212] + (1.84 \pm 0.26) \times 10^{-10}[T^5J_5(\Theta/T)/124.4]$, where T is in °K; J_3 and J_5 are integrals occurring in the Wilson and Block theories, respectively; and the best value for Θ, the effective Debye temperature, is (270 ± 10)°K. The data are normalized so that $\rho(298°K) = 1$. The fitting scheme, which might be best described as a least-squares fractional-error fit, yielded a standard deviation of 2.6% per datum. The limits on the coefficients were obtained by varying each coefficient separately so as to make the fit worse by 1 standard deviation. In this analysis, the Bloch term contributes about 55% to the total resistivity at room temperature and the Wilson term about 45%. Over most of the temperature range below 300°K, the T^3 Wilson term dominates. Thus, it is concluded that interband scattering is quite important in niobium. Because of the large magnitude of interband scattering, it was difficult to determine the precise amount of T^2 dependence in the resistivity. Several schemes for establishing an upper bound to this term were employed. The smallest, but still reliable, upper bound for the coefficient of this term BT^2

was found to be $B \leq 5.7 \times 10^{-7}$ in the normalized units. This corresponds to about $B \leq 8 \times 10^{-12}$ Ω cm/deg^2, which is more than an order of magnitude smaller than previously thought for niobium. There is an interesting relation between the intraband term in niobium and the total resistivity of molybdenum; it is found that they are nearly equal at their respective Debye temperatures. This result is briefly discussed in terms of their respective d-band densities of states. (auth)

39564 A SELF-CONSISTENT APPROACH TO SPIN SYSTEMS: DYNAMICAL CRITICAL PHENOMENA. Kawasaki, Tatuo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 322-38(Feb. 1969).

A self-consistent equation is proposed for the dynamical variable of the Heisenberg spin system. On the basis of this equation, the dynamical scaling law can be understood as a particular property of the most dominant part responsible for the critical anomaly. Critical exponents of characteristic frequencies are $(5 + \eta)/2$ and $(3 + \eta)/2$ in ferro- and antiferromagnets, respectively. When transfer wave vectors in inelastic neutron scattering experiments exceed a certain value, the absorption spectrum is no longer Lorentzian or Gaussian and often shows collective-mode-like peaks. Conditions for the appearance of such peaks are also discussed. (auth)

39565 ELECTRICAL PROPERTIES OF THE RARE-EARTH OXIDES AND SEVERAL OF THEIR COMPOUNDS. Zyrin, A. V.; Dubok, V. A.; Tresvyatskii, S. G. pp 63-8 of Chemistry of High-Temperature Materials. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969.

From 2nd All-Union Conference on the High-Temperature Chemistry of Oxides, Leningrad, USSR. See CONF-651160.

Results of electric conductivity and thermo-emf measurements as a function of temperature performed on the pure oxides of scandium, yttrium, neodymium, and gadolinium at two oxygen partial pressures (0.2 and 10^{-5} atm) are presented. Results on the chromites of the rare-earth series at $P_{O_2} = 0.2$ atm and at different concentrations of doped impurities are given. The fraction of ionic conductivity in the pure oxides was also measured. All measurements were performed on polycrystalline samples prepared by usual ceramic methods. (TSS)

39566 IONIC AND ELECTRONIC CONDUCTIVITY OF SAMPLES FROM THE ZrO_2–$PrO_{1.83}$ SYSTEM. Volchenkova, Z. S. pp 69-73 of Chemistry of High-Temperature Materials. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969.

From 2nd All-Union Conference on the High-Temperature Chemistry of Oxides, Leningrad, USSR. See CONF-651160.

The dependence of the ionic and electronic components of electric conductivity on the temperature and sample composition was studied in the praseodymium oxide–zirconium oxide system. The nature of the electrical conductivity of specimens fired in air at 1550°C was determined by the emf method for samples from the ZrO_2–$PrO_{1.83}$ system over a broad composition range (0 to 70 mole %) and temperature range (600 to 1000°C). The isotherms were constructed for the ionic and electronic components of the electrical conductivity in the ZrO_2–$PrO_{1.83}$ system. The data obtained were considered in light of the theory on ionic-crystal solid solutions. (D.H.M.)

39567 METHOD FOR COMPUTING THE ELECTROSTATIC ENERGY OF THE COMPLEX AND DEFECT LATTICES OF IONIC COMPOUNDS. Boganov, A. G.; Cheremisin, I. I.; Rudenko, V. S. pp 12-19 of Chemistry of High-Temperature Materials. Toropov, N. A. (ed.). New York, Consultants Bureau, 1969.

From 2nd All-Union Conference on the High-Temperature Chemistry of Oxides, Leningrad, USSR. See CONF-651160.

The comparative stability of the low- and high-temperature modifications of Pr_2O_3 is assessed, using an ionic model. The lattice energies of the intermediate, stoichiometric phases of the compound PrO_x ($1.5 \leq x \leq 2$) that have defect structures were evaluated. A direct method developed earlier by the authors (Dokl. Akad. Nauk SSSR, 161: 590(1965)) for computing lattice sums of distorted and complex cubic lattices was used, as well as a special superpositional method for computing the Mandelung constant of defect lattices. (L.M.T.)

39568 CRITICAL AND SPIN-WAVE FLUCTUATIONS IN NICKEL BY NEUTRON SCATTERING. Minkiewicz, V. J.; Collins, M. F.; Nathans, R.; Shirane, G. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 182: 624-31(June 10, 1969).

This paper gives direct measurements of the frequency- and wave-vector-dependent critical scattering of neutrons from nickel. Extensive measurements have been made around the Curie temperature to study the critical fluctuations in detail, particular emphasis being placed on the dynamics of these fluctuations. Below the Curie temperature T_c, the fluctuations can be described in terms of spin-wave excitations with an exchange stiffness constant D that varies with temperature as $(1 - T/T_c)$ to the power 0.39 ± 0.04. The spin waves become over-critically damped just below T_c. Right at the critical temperature, the energy width of the scattering is observed to vary as the wave vector q to the power 2.46 ± 0.25, in excellent agreement with the predictions of the dynamic scaling laws. Above T_c, in the hydrodynamic region, the spin-diffusion constant is observed to vary as $(1 - T_c/T)$ to the power 0.51 ± 0.05, in marked contrast to theoretical predictions of a value close to 0.33. Comparison with our recent data for iron suggests that spin diffusion in the two materials may be occurring with different dominant mechanisms. As in iron, no scattering was observed from diffusive components of the susceptibility for $T < T_c$; this result contrasts strongly with the scattering observed from the Heisenberg antiferromagnet $RbMnF_3$, where a diffusive mode is clearly seen. Extensive data have been taken of the spin-wave dispersion relations at room temperature. Interpretation of the data in terms of a Heisenberg model leads to the conclusion that the exchange is long-range in extent, with ferromagnetic interactions present over short ranges and antiferromagnetic interactions predominating over longer ranges. (auth)

39569 HIGH-COERCIVE-FORCE RARE-EARTH ALLOY FILMS BY GETTER SPUTTERING. Theuerer, H. C.; Nesbitt, E. A.; Bacon, D. D. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 40: 2994-6(June 1969).

Thin films of the rare-earth alloys of the Co–Sm system with and without the addition of Cu were found to have exceptionally high coercive forces. A coercive force of 30,000 Oe was realized with $Co_{3.65}Cu_{1.35}Sm$ films, 4000-Å thick prepared at a substrate temperature of 500°C using getter sputtering. This technique avoids troublesome oxidation problems usually encountered in preparing films of active materials such as the rare-earth compounds. (auth)

39570 FREQUENCY DEPENDENCE OF MAGNETIC LOSSES IN Ho IN THE NEIGHBORHOOD OF THE CURIE TEMPERATURE. Olander, F.; Gerstein, B. C. (Ames Lab., Iowa). J. Phys. Chem. Solids, 28: 1705-12(1967). (IS-1476).

The frequency dependence of the imaginary and real susceptibilities of polycrystalline Ho has been measured in the neighborhood of the ferromagnetic ordering temperature. The nature of the $\chi' - \omega - T$ and $\chi'' - \omega - T$ surfaces has been defined in the range $10 \leq T \leq 25$°K, $22 \leq \omega \leq 110$ Hz at 10°. For the sample measured, the magnetic losses are nonnegligible above 22 Hz, indicating that ac susceptibilities of Ho measured above this frequency will not agree with dc measurements. The results were fitted to a driven oscillator model for domain motion and were found to correlate more closely with a model in which effective mass is ignored than with one in which it is not. The agreement is not satisfactory, however, and the reasons for the lack in the model are discussed. (auth)

39571 NUCLEAR RELAXATION IN PLUTONIUM PHOSPHIDE ABOVE THE CURIE TEMPERATURE. Fradin, F. Y. (Argonne National Lab., Ill.). Solid State Commun., 7: 759-61(May 15, 1969).

The nuclear spin–lattice relaxation time T_1 of ^{31}P in PuP was found to decrease sharply with decreasing temperature. The dependence of T_1 on temperature is discussed in terms of the s–f coupling of the conduction electrons to the spin of the magnetic ion. (auth) (UK)

39572 MAGNETIC SUSCEPTIBILITIES OF THE MONONITRIDES AND SESQUICARBIDES OF THORIUM, URANIUM, AND PLUTONIUM. Raphael, Georges; de Novion, Charles (CEN, Fontenay-aux-Roses, France). Solid State Commun., 7: 791-3(May 15, 1969). (In French).

The magnetic susceptibilities of ThN, UN, PuN, U_2C_3, and Pu_2C_3 between 4° and 1000°K were measured. The magnetic susceptibilities of ThN and Pu_2C_3 were found to be temperature independent. The susceptibilities of UN, U_2C_3, and PuN are maximum at respective temperatures of 52°, 59°, and 12°K; above these temperatures these susceptibilities follow an approximate Curie–Weiss law. (auth) (UK)

39573 THE THEORY OF THE ELECTROSTATIC SCATTERING OF THERMAL NEUTRONS BY SOLIDS. Lovesey, S. W. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., C (London), 2: 981-7(June 1969).

The consequences of the electrostatic interaction involved in the scattering of thermal neutrons by both nonmagnetic and magnetic crystals are discussed. The terms in the cross section and also in the polarization of an initially unpolarized beam, additional to those coming from just the nuclear and magnetic interactions, are calculated. It is pointed out that the electrostatic interaction consists of two terms: first, the well known spin–orbit term considered by Schwinger (1948), and secondly, the so-called Foldy (1958) interaction which was omitted in previous calculations for the scattering of thermal neutrons by crystals. The inclusion of the

Foldy interaction is shown to modify the previous results significantly. (auth) (UK)

39574 OVERLAP OF INTEREST BETWEEN HYPERFINE INTERACTION MEASUREMENTS AND ION IMPLANTATION. Stone, N. J. (Clarendon Lab., Oxford). Proc. Roy. Soc. (London), Ser. A, 311: 3-10(June 24, 1969).

Ion implantation involves the theory and experimental techniques of accelerating ion beams, the passage of accelerated ions in solids, their slowing down and stopping, and their final positions in the lattice. Interest is centered on the modifications the implanted ions produce in lattice properties and the variation of these modifications with parameters such as the total number and incident energy of the incident ions and the heat treatment of the lattice. Hyperfine interaction measurements involve the product of a nuclear electromagnetic moment, electric monopole (charge), magnetic dipole, electric quadrupole, etc., with the appropriate property of the environment of the nucleus, namely the electron charge density, the magnetic field, or the electric field gradient. The areas in which the fields of current interest of these two branches of physics overlap are briefly outlined. The requirements and capabilities of hyperfine interaction measurements, concentrating on the magnetic dipole case are considered, and it is shown how these may be fulfilled and extended with the aid of ion implantation techniques. It is also considered how hyperfine interaction studies could be applied to problems in the use of ion implantation for other purposes. (auth) (UK)

39575 EFFECT OF THE MOLECULAR FIELD ON THE ELECTRICAL RESISTIVITY NEAR A MAGNETIC TRANSITION: $GdNi_2$. Kawatra, M. P.; Skalski, S.; Mydosh, J. A.; Budnick, J. L. (Fordham Univ., Bronx, N. Y.). Phys. Rev. Lett., 23: 83-6(July 14, 1969).

The temperature dependence of the electric resistivity of the cubic, Laves-phase, ferromagnetic, intermetallic compounds $GdNi_2$, $GdPt_2$, and $GdRh_2$ was measured, and for $GdNi_2$, the temperature derivative of the electric resistivity in the neighborhood of the magnetic transition was analyzed. Above the Curie temperature, the data are very well described by the molecular-field treatment of the long-range spin fluctuations of the short-range order, giving for the first time an experimental result in agreement with this treatment. (auth)

39576 FESTKOERPER PROBLEME. VIII. (Solid-State Problems. VIII). Madelung, O. (ed.). New York, Pergamon Publishing Company, 1968. 315p. (In German and English).

Separate abstracts were prepared for two of the ten papers, one on radiation damage in semiconductors, the other on the present theory of type-II superconductors. (L.M.T.)

For abstracts of individual papers see: 39423 and 39540.

39577 MOESSBAUER EFFECT STUDY OF THE METALLIC COMPOUNDS U_6Fe AND Pu_6Fe, AND THE RELEVANCE OF THE RESULTS TO THEORIES OF THE BEHAVIOUR OF ACTINIDE METALS. Blow, S. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys. Chem. Solids, 30: 1549-59(June 1969).

From the Moessbauer point of view the results obtained for these compounds were straightforward; quadrupole pairs were seen in both materials at room temperature and low temperatures. Low-temperature values for the splittings were 0.074 cm/sec for U_6Fe and 0.083 cm/sec for Pu_6Fe; the corresponding-room temperature values were 0.069 and 0.073 cm/sec. Both quadrupole splittings and isomeric shift values were characteristic of Fe in the metallic state. Recent electrical resistivity studies have established that the temperature curves for Pu_6Fe and Pu metal are qualitatively very similar. In view of this, and the Moessbauer results, the author is inclined to reject the hypothesis that Pu undergoes an antiferromagnetic transition at low temperatures. The situation is complex, however, and a review and appraisal are made of the theories proposed to explain the properties of this unusual metal. (auth) (UK)

39578 ANTIFERROMAGNETIC STRUCTURES OF USb AND UBi. Kuznietz, H.; Lander, G. H.; Campos, F. P. (Argonne National Lab., Ill.). J. Phys. Chem. Solids, 30: 1642-3(June 1969).

Neutron-diffraction studies of USb and UBi are reported. The antiferromagnetic structure of both materials is type-I. When the materials were cooled to 5°K no abrupt change in the ordered moment occurred. The ordered moments and Neel temperatures are given. (UK)

Moessbauer Effects and NMR

Refer also to abstract 38150.

39579 PARAMAGNETIC RESONANCE OF Eu^{2+} DISSOLVED IN Yb METAL. Schaefer, W. (Technische Hochschule, Darmstadt, Ger.); Schmidt, H. K.; Huefner, S.; Wernick, J. H. Phys. Rev., 182: 459-62(June 10, 1969).

The paramagnetic resonance of Eu^{2+} dissolved in Yb metal was measured between 1.6 and 77°K. The g value is $g = 1.970 \pm 0.005$, displaying a g shift outside the experimental error. The increase in linewidth with temperature is $dW/dT = 24 \pm 4$ G/°K independent of the Eu concentration. Assuming that this is caused by the Korringa mechanism, this temperature-dependent linewidth yields a g shift of $|\Delta g| = 0.031$. From the g shifts, the exchange integral between the Eu spins and the conduction electrons is derived as $J = -0.02$ eV. (auth)

39580 BAND STRUCTURE AND ^{197}Au NUCLEAR-MAGNETIC-RESONANCE STUDIES IN $AuAl_2$, $AuGa_2$, AND $AuIn_2$. Switendick, A. C.; Narath, Albert (Sandia Labs., Albuquerque, N. M.). Phys. Rev. Lett., 22: 1423-6(June 30, 1969).

Measurements of the ^{197}Au Knight shift in $AuAl_2$, $AuGa_2$, and $AuIn_2$ are reported. In contrast to the strong temperature dependence of the ^{71}Ga Knight shift, only a weak temperature dependence of the ^{197}Au Knight shift in $AuGa_2$ is observed. Electronic energy-band calculations for these compounds yield differences which provide an improved model for interpreting these and other experimental results. (auth)

39581 DETERMINATION OF THE MAGNETIC HYPERFINE FIELD OF Hf IN Fe BY MOESSBAUER EXPERIMENTS. Steiner, P.; Gerdau, E.; Steenken, D. (Institut fuer Experimentalphysik, Hamburg). Proc. Roy. Soc. (London), Ser. A, 311: 177-9 (June 24, 1969).

Mössbauer experiments with the 93-keV $2^+ - 0^+$ γ-transition in ^{178}Hf and ^{180}Hf to determine the magnetic hyperfine field of Hf in Fe are described. A source of 22d ^{178}W was used for the ^{178}Hf experiments, produced by a $^{181}Ta(d, 5n)\ ^{178}W$ reaction. After adding 5 mg tungsten the activity was chemically separated from tantalum, and the separated tungsten was reduced to metal in a hydrogen atmosphere at about 1170°K. The tungsten powder was mixed with iron powder (1 at. % W in Fe) and melted in an induction furnace. The resonance absorber was HfN. With a cubic tungsten source these absorbers showed single-line transmission spectra of about 1.5 times the natural line width $2\Gamma_0$. With the Fe(W)-source and an HfN absorber at 4.2 and 77°K broad but symmetric transmission spectra of about 5.5 times the natural width $2\Gamma_0$, due to hyperfine interactions in the source, were obtained. These spectra were fitted with a 5-line hyperfine pattern with equal width and intensity for each line, assuming a combined magnetic and electric hyperfine interaction. For the ^{180}Hf experiments an Hf–Fe alloy (1 at. % Hf in Fe) was used. The 5.5-hr $^{180}Hf^m$ activity was produced by neutron irradiation. The transmission spectrum with an HfN absorber again showed a broadened symmetric transmission line, but of only 3.5 times the natural width $2\Gamma_0$. (auth) (UK)

39582 ON THE MAGNETIC HYPERFINE FIELD AT Hf IN IRON AND THE GYROMAGNETIC FACTORS g_K AND g_R OF THE 624 ROTATIONAL BAND OF ^{177}Hf. Huebel, H. (Univ., Bonn); Toschinski, H.; Bodenstedt, E.; Freitag, K. Proc. Roy. Soc. (London), Ser. A, 311: 181-4(June 24, 1969).

The induced magnetic hyperfine field acting on ^{177}Hf nuclei implanted into an iron foil by means of an isotope separator was determined by measuring the integral rotation of the 208–113 keV γ–γ directional correlation. By using the previously known values of the g factor and the lifetime of the 113-keV state of ^{177}Hf a value of $-(286 \pm 40)$ kOe was obtained for the effective internal field. The same source was used to measure the g factor of the 321-keV excited level in ^{177}Hf, which is the ground state of the $K = 9/2^+$ [624] rotational band. The measurement of the integral rotation of the 105–208 keV cascade yielded the value $g(321) = -0.113 \pm 0.038$. The combination of the g factor and the M1/E2 mixing ratios of the $\Delta I = 1$ transitions in the [624] rotational band in ^{177}Hf, which were determined from directional correlation measurements employing Ge(Li) detectors, gave $g_K = -0.18 \pm 0.05$ and $g_R = 0.19 \pm 0.05$. (auth) (UK)

39583 COULOMB EXCITATION MOESSBAUER EFFECT OF THE 43.8-keV STATE OF ^{161}Dy. Sylvester, S.; McQueen, J. E.; Schroeer, D. (Univ. of North Carolina, Chapel Hill). Contract SD-100. Solid State Commun., 7: 673-5(May 1969).

The Mössbauer effect of the 43.8-keV transition in ^{161}Dy was studied following Coulomb excitation with 3.3-MeV α particles at liquid nitrogen and helium temperatures. (auth) (UK)

39584 QUADRUPOLE INTERACTION OF ^{181}Ta IN Hf COMPOUNDS. Gerdau, E.; Wolf, J.; Winkler, H.; Braunsfurth, J. (Institut fuer Experimentalphysik, Hamburg). Proc. Roy. Soc. (London), Ser. A, 311: 197-206(June 24, 1969).

Time-differential angular-correlation studies of the electric quadrupole interaction of ^{181}Ta in various Hf compounds are presented, and methods for the analysis of the time spectra are dis-

cussed. The experiments yielded information on the strength of the quadrupole interaction, and on the axial asymmetry and distribution of the field gradient. Electric field gradients V_{zz} are derived for ^{181}Ta in Hf metal, HfO_2, and $(NH_4)_2HfF_6$. (auth) (UK)

39585 MOESSBAUER EXPERIMENTS WITH COULOMB-EXCITED ^{61}Ni AND ^{73}Ge AFTER RECOIL IMPLANTATION. Seyboth, D. (Univ., Erlangen, Ger.). Proc. Roy. Soc. (London), Ser. A, 311: 119-22(June 24, 1969).

A description is given, from the point of view of ion implantation, of the results of Moessbauer measurements in ^{61}Ni and ^{73}Ge after Coulomb excitation of the relevant nuclear energy levels. The experiments were carried out like "classical" Moessbauer studies. Instead of a radioactive source, however, a target was used containing the same isotope as the absorber. The target nuclei were Coulomb excited by bombardment with oxygen ions of 20 to 30 MeV from a tandem Van de Graaff, the projectiles transferring recoil energy to the excited nuclei. The maximum recoil energy in the laboratory system was about 15 MeV. The Moessbauer atom leaves its lattice site and moves through the target material, and in this way it can be implanted into the target substrate. The slowing down process is finished in a time short compared to the lifetime of the excited level. The final environment of the excited Moessbauer nucleus determines such details of the Moessbauer effect as the recoilless fraction, the isomer shift and the hyperfine splitting. The chosen cryogenic target chamber made it possible to keep target and absorber close to liquid nitrogen temperature, though the heat input due to the oxygen ions was about 25 W. (auth) (UK)

39586 YADERNYI MAGNITNYI REZONANS. VYPUSK III. (Nuclear Magnetic Resonance. 3rd Edition). Borodin, P. M. (ed.). Leningrad, Izdatel'stvo Leningradskogo Universiteta, 1969. 140p.

Eighteen articles are included on the theory and applications of nuclear magnetic resonance and electron paramagnetic resonance in a weak magnetic field. Problems of NMR and results of experiments with the structure and molecular dynamics of liquid and solid states are discussed. Construction and performance of various devices (nuclear-resonance differential geomagnetometers, free nuclear precision transducers, pulse relaxometers and automatic and temperature stabilizers for NMR transducers) are discussed. (R.V.J.)

Theoretical Physics

Refer also to abstracts 39291, 39345, 39421, 39475, 39624–39626, and 39638–39640.

39587 GOING OVER FROM CLASSICAL TO QUANTUM MECHANICS. III. RELATIVISTIC THEORY OF IRREDUCIBLE SPINORS. Ionescu-Pallas, N. J. (Bucharest Inst. of Nuclear Physics). Stud. Cercet. Fiz., 21: 9-20(1969). (In Rumanian).

The behavior of irreducible spinors under space reflection is investigated and separation of parity states is achieved by a unitary transformation. Further, finite Lorentz transformations in explicit form are found out for irreducible spinors. For a spin-$\frac{1}{2}$ particle, a new kind of spinor, called "Pauli spinors," which transform relativistically like the square root of a density, are introduced and the relationship between these spinors and the conventional ones is established via finite Lorentz transformations. In this way, the probability concept enters naturally the quantum mechanics and the Dirac equation follows as a consequence. For particles with spin greater than $\frac{1}{2}$, the wave function is interpreted in terms of an interaction field and a nonlinear wave equation is suggested for particles with arbitrary spin. (auth)

39588 NEW CLASSICAL AND RELATIVISTIC HYDRODYNAMIC SCHEMES FOR A PARTICLE WITHOUT SPIN. Boeda, Michel (Centre de Recherche de Chimie, Paris). Compt. Rend., Ser. B, 268: 1160-3(May 5, 1969). (In French).

Following the hypotheses of correspondence between the field representing a particle and a figurative fluid, and expressing classically or relativistically the equations for a fluid, a generalized nonlinear wave equation of the Schroedinger (or Klein–Gordon) type is deduced. (tr-auth)

39589 KINETIC EQUATION FOR THE SYSTEM OF INTERACTING PARTICLES. Kon'kov, V. L.; Kasatkin, A. P. (Gorky Research Inst. of Physics and Tech., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 71-5(1969). (In Russian).

A new kinetic equation for a system of interacting particles was obtained and used in studies of thermodynamics of high-temperature electron gas. (R.V.J.)

39590 MANY BODY VARIATION THEORY. I. PAIR CORRELATION. Sawada, Katuro (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto), 41: 664-74(Mar. 1969).

A method to go beyond the Hartree–Fock approximation for the many-body system is developed for the N-Fermion system with two-body interaction acting on the anti-parallel spin particles. The variational energy can be shown to be related to the usual sum of random-phase-approximation contributions (ring-diagram sum) with propagators modified by ring diagrams. Only the formal expressions for the energy were derived in this article, leaving further exploration for later publication. (auth)

39591 WAVES AND PARTICLES. Wild, Wolfgang (Technische Hochschule, Munich). pp 9-23 of Atome, Kerne, Elementarteilchen. Suessmann, Georg; Fiebiger, Nikolaus (eds.). Frankfurt am Main, Umschau Verlag, 1968. (In German).

The basic concepts of classical physics are outlined. The particle character of light and the wave character of matter are described. The statistical interpretation of the wave functions is considered. (J.S.R.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

39592 (TID-25098) LAWRENCE RADIATION LABORATORY, BERKELEY, 1967. (California Univ., Berkeley. Lawrence Radiation Lab.). 1967. 124p. Dep. CFSTI.

The activities in the fields of physics, nuclear chemistry, inorganic materials, biology and medicine, and chemical biodynamics are outlined. Comprehensive articles on the measurement of the eta zero-zero, red blood cells, photosynthesis, the chemistry of einsteinium, and the science of surfaces are included. Research highlights of 1967 and spin-off from basic research are discussed. A list of research papers published during 1967 is appended. (C.E.S.)

Electromagnetic

Refer also to abstracts 38313 and 39351.

39593 (NYO-3399-193) APPLICATION OF RELATIVISTIC RESONANCE FORMULA TO THE $e^+e^- \rightarrow \pi^+\pi^-$ EXPERIMENT. Parkinson, Michael (Syracuse Univ., N. Y. Dept. of Physics). May 1969. 17p. (SU-1206-193). Dep. CFSTI.

The present data for the reaction $e^+e^- \rightarrow \pi^+\pi^-$ is analyzed with the aid of a general effective range resonance formula for the ρ meson. It is concluded that: (a) $m_\rho = 769 \pm 5$ MeV and $\Gamma_\rho = 109 \pm 10$ MeV provide a reasonable explanation of the present experimental points. (b) The full width at half maximum regardless of the peak height should give an excellent estimate of the ρ width. (c) It is hard to escape $|F_\pi(m_\rho^2)|^2 = m_\rho^2/\Gamma_\rho^2$. (d) The effects of final state interactions on resonance shape ought to be investigated. (auth)

39594 THE PHOTOPRODUCTION OF ETA-MESONS BETWEEN 950 MeV AND 2.2 GeV. Booth, P. S. L. (Univ. of Liverpool); Butler, M. F.; Carroll, L. J.; Holt, J. R.; Jackson, J. N.; Range, W. H.; Williams, E. G. H.; Wormald, J. R.; Tait, N. R. S. Nuovo Cim., Lett., 2: 66-70(July 11, 1969).

The differential cross sections were measured for photoproduction of η mesons on protons at 950 MeV to 2.2 GeV. This process $\gamma + p \rightarrow p + \eta$ ($\eta \rightarrow 2\gamma$) was detected through double coincidences between protons and single photons produced by decay in the forward direction of the η meson. The incident energies at which various resonances would be excited are indicated. (J.F.P.)

39595 UPPER LIMIT FOR RELATIVISTIC DIRAC MONOPOLE FLUX AT MOUNTAIN HEIGHTS. Eriykin, A. D.; Yakovlev, V. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Theor. Fiz., 56: 1849-50(June 1969). (In Russian).

The flux of relativistic Dirac monopoles of various energy is estimated by means of aboveground and underground calorimeters at the high altitude scientific station of the Lebedev Physical Institute. For energies $E \geq 10^{13}$ eV the monopole flux $I \leq 2.5 \cdot 10^{-12}$ cm$^{-2} \cdot$ sec$^{-1} \cdot$ sterad^{-1}; for $E \geq 3 \cdot 10^{13}$ eV, $I \leq 7 \cdot 10^{-13}$ cm$^{-2} \cdot$ sec$^{-1} \cdot$ sterad^{-1}. (auth)

39596 CHARGE RATIO OF HIGH-ENERGY COSMIC-RAY MUONS AT LARGE ZENITH ANGLES. Fujii, Z. (Nagoya Univ., Japan); Iida, S.; Kamiya, Y.; Kawaguchi, S.; Takenaka, A. Nuovo Cim., Lett., 1: 845-7(June 1, 1969).

From previous results on the observation of the muon charge ratio in the momentum range of approximately 20 to 100 GeV/c at the time of production it was concluded that there is a minimum of the charge ratio around 80 GeV/c at production. This experimental result is reinvestigated and the previous measurement is extended to higher energies. The observed muon charge ratio and the statistical error is shown plotted as a function of the momentum at production. The ratio is approximately constant in the range of 20 to 500 GeV/c and has a mean value of 1.293 ± 0.019. (J.F.P.)

39597 AZIMUTH ANGLE DISTRIBUTION OF THE SECONDARY PARTICLES OF COSMIC-RAY JETS. Imaeda, K.; Fleming, P. (Dublin Inst. for Advanced Studies). Nuovo Cim., 62A: 439-48(July 21, 1969).

The azimuth angle distribution of a group of particles forming a diffused cone of cosmic-ray jets with energy greater than 10^{11} eV and with $N_h \leq 1$ was analyzed. The distribution shows the azimuth asymmetry. The asymmetry may be attributed to the emission of an isobar or a meson resonance with a transverse velocity $\bar{\beta}_t = 0.4 \div 0.65$ to the direction of motion of the primary. The upper limit of the value of the transverse momentum of those groups of particles in the diffused cone deduced from the azimuth-angle asymmetry is ~1.0 to ~3.0 GeV/c. (auth)

39598 PHOTOGENERATION OF PIONS. Csikor, Ferenc; Montvay, Istvan (Eoetvoes Lorand Univ., Budapest). Magy. Fiz. Foly., 17: 165-227(1969). (In Hungarian).

Strong and electromagnetic interactions are jointly involved in scattering phenomena when the original state is γ (photon) or e (electron) + N (nucleon); the final states may include photons, electrons and hadrons. In this connection, the photogeneration of π mesons is reviewed, restricting the study to photon energies below 1 GeV. The processes examined include (1) $\gamma p \rightarrow \pi^+ n$; (2) $\gamma p \rightarrow \pi^0 p$; (3) $\gamma n \rightarrow \pi^- p$; and (4) $\gamma n \rightarrow \pi^0 n$. Process 1 is best known at present; the second one presents some additional experimental difficulties related to the detection of π^0. The problems involved in process 3 are due to the fact that the neutron target may be realized only by bombarding deuterons or heavier nuclei. The measurements must be corrected to separate out the effect of nuclear forces; this cannot be carried out easily if the strong interaction is not well studied. For this reason, lately the inverse process has been examined experimentally; the radiative pion capture by protons; the $\pi^- p \rightarrow \gamma n$ offers promise. The development of the theoretical basis of photogeneration on the basis of dispersion relations by Chew, Goldberger, Low and Nambu, and the subsequent history of the field are also discussed. (Review article) (TTT)

39599 π^0 PHOTOPRODUCTION FROM HYDROGEN BETWEEN 574 AND 1211 MeV. Wolverton, Franklin Bruce. Pasadena, Calif., California Inst. of Tech., 1968. 284p.

Thesis.

Cross section angular distributions for π^0 photoproduction from hydrogen were measured for 28 laboratory photon energies from 574 to 1211 MeV. At most energies, the π^0 center of mass angle was varied from 60° to 170° in steps of 10°. A magnetic spectrometer was used to measure the momentum and angle of the recoil proton. A scintillation counter hodoscope with lead converters was used to detect the presence of at least one of the π^0 decay gamma rays. For a majority of the measurements the π^0 rates were separated from a contamination of pi pair rates using the difference in their distribution among the gamma counters. For the remainder of the measurements, charged pi pairs were eliminated using veto counters in front of the gamma counters. Internal consistency and comparison with other experiments indicate that the veto data are 10 to 15% low near 90° in the region of 750 MeV. The remainder of the data show good internal consistency and fair agreement with data of other experiments. The results show a peak at 140° near 1050 MeV which had been expected but not previously measured. Comparison of the backward angle data with that from experiments measuring cross sections very near 180° indicates either an inconsistency between experiments or a rapid drop in the cross section near 180° in the region around 800 MeV. (Diss. Abstr.)

Weak

Refer also to abstract 39203.

39600 (COO-1749-9) ELECTRON ANTINEUTRINO INTERACTION WITH DEUTERONS. Jenkins, T. L. (Case Western Reserve Univ., Cleveland, Ohio. Dept. of Physics); Kinard, F. E. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.); Reines, F. (California Univ., Irvine. Dept. of Physics). [nd]. 33p. Dep. CFSTI.

The reaction $\bar{\nu}_e(d,2n)e^+$ was observed using anti-neutrinos from a powerful fission reactor. The measured cross section $\bar{\sigma}_{exp} = 3.0 \pm 1.5 \times 10^{-45}$ cm^2/fission $\bar{\nu}_e$ is consistent with expectations, $\bar{\sigma}_{theory} = 2.4 \pm 0.4 \times 10^{-45}$ cm^2/fission $\bar{\nu}_e$, based on the two component neutrino theory and elementary considerations regarding the structure of the deuteron. (auth)

39601 (COO-1749-11) A RESEARCH PROGRAM IN HIGH ENERGY ACCELERATOR PHYSICS AND LOW LEVEL COUNTING ELEMENTARY PARTICLE PHYSICS. Technical Report, October 1, 1968-September 30, 1969. Jenkins, Thomas L. (Case Western Reserve Univ., Cleveland, Ohio). June 1969. Contract AT(11-1)-1749. 8p. Dep. CFSTI.

Research on the neutrino and low level counting, $\pi^- + p$ charge exchange scattering at high momentum transfer, and CP asymmetry in the decay $K_2^0 \rightarrow \pi^+ + \pi^- + \pi^0$ is briefly described. (W.H.K.)

39602 (UCRL-19226) A TEST OF THE $\Delta S = \Delta Q$ RULE IN LEPTONIC DECAYS OF NEUTRAL K MESONS. Webber, Bryan Ronald (California Univ., Berkeley. Lawrence Radiation Lab.). May 10, 1969. Contract W-7405-eng-48. 78p. Dep. CFSTI.

Thesis.

In 1.3 million hydrogen bubble chamber pictures, taken during an exposure of the 25-inch Lawrence Radiation Laboratory chamber to a 400 MeV/c K^- beam, about 18,000 reactions of the type $K^-p \rightarrow \bar{K}^0n$ followed by a visible decay of the neutral K meson were found. After applying many selection criteria, 252 events are found in which the decay is leptonic or radiative: neutral $K \rightarrow \pi^\pm e^\mp \nu$, $\pi^\pm \mu^\mp \nu$, or $\pi^+\pi^-\gamma$. An electron was identified in 81 of these events, and a muon in 38 of them. The remaining 133 events are treated as completely ambiguous between the leptonic and radiative decay hypotheses. By studying the time distributions of the identified and the ambiguous events, the $\Delta S = \Delta Q$ selection rule is tested and also the Sachs model of CP violation, which predicts a large CP-violating $\Delta S = -\Delta Q$ term in the leptonic decay amplitudes. Parameters, x are defined for the electronic decay distributions and x' for the muonic, that are real if CP is conserved in the leptonic decays and are zero if $\Delta S = \Delta Q$. From the identified events, it is found that $Re(x) = 0.30^{+0.19}_{-0.13}$, $Im(x) = 0.07^{+0.19}_{-0.08}$ and $Re(x') = 0.19^{+0.13}_{-0.18}$, $Im(x') = -0.12^{+0.21}_{-0.17}$. Since these results are consistent with the hypothesis $x = x'$, this assumption is made in order to parametrize the distribution of ambiguous events in terms of x, and combine the results for all 252 events, to obtain $Re(x) = 0.25^{+0.07}_{-0.06}$, $Im(x) = 0.00 \pm 0.08$. The relative likelihood of the value $x = 0$ is $e^{-3.2}$, so this value lies about 2.5 standard deviations from the most likely value, and to this extent the experiment indicates a violation of the $\Delta S = \Delta Q$ rule. No significant imaginary part of x, is found, which makes the Sachs mechanism of CP violation appear unlikely, although this model may not be ruled out with certainty, since it makes only an order-of-magnitude prediction of Im(x). In order to correct the distribution of the ambiguous events for the background of $\pi^+\pi^-\gamma$ decays, it must be assumed that radiative decay occurs only through inner bremsstrahlung in the process $K_S \rightarrow \pi^+\pi^-$. A study of 10 kinematically unambiguous $\pi^+\pi^-\gamma$ decays gives experimental support to this assumption. As consistency checks on the data, the leptonic decay rate of the K_L, $\Gamma_L(l)$, and the absolute value of the $K_S - K_L$ mass difference, $|\delta|$ are measured. Assuming the most likely value of x, it is found that $\Gamma_L(l) = (11.5 \pm 1.1) \times 10^6$ sec^{-1} and $|\delta| = (0.56^{+0.10}_{-0.08}) \times 10^{10}$ sec^{-1}, in good agreement with the established values of these quantities. (auth)

39603 EXPERIMENTAL TEST OF UNIVERSALITY IN $\Sigma^- \rightarrow n l^- \nu$. Baggett, N. V.; Kehoe, B.; Snow, G. A. (Univ. of Maryland, College Park). Phys. Rev. Lett., 23: 249-51(Aug. 4, 1969).

In a 540,000-frame stopping-K^- exposure at the Brookhaven National Laboratory alternating-gradient synchrotron, the branching ratio $\Gamma(\Sigma^- \rightarrow n\mu^-\nu)/\Gamma(\Sigma^- \rightarrow \text{all})$ is found to be $(0.43 \pm 0.09) \times 10^{-3}$. Combining this with the world-average $\Sigma^- \rightarrow ne^-\nu$ branching ratio of $(1.10 \pm 0.05) \times 10^{-3}$ gives $\Gamma_\mu/\Gamma_e = 0.39 \pm 0.08$, which agrees with the universal V-A prediction of 0.45. (auth)

39604 IMPLICATIONS OF A NEW PRODUCTION PROCESS OF 10^{12}- TO 10^{13} -eV MUONS. Mason, Grant William. Salt Lake City, Univ. of Utah, 1969. 142p.

Thesis.

Data on zenith-angle dependence of cosmic ray muon intensities in the energy range 1 to 10 TeV were gathered using the kiloton neutrino detector of the University of Utah and using the rugged Wasatch Mountains as energy analyzer. Analysis of the zenith-angle dependence suggests that the muon flux consists of a component from the decay of pions and kaons and a component from the decay of a short lived ($t_\phi \ll 10^{-7}$ sec), massive ($m_\chi > 3$ GeV) new particle. A simple model is proposed and a differential muon spectrum is calculated. Survival probabilities for muons of energy E to reach depth h are calculated to within an estimated 5 percent by a Monte Carlo technique and are used to compare the calculated muon spectrum with measured intensities at slant depths, ranging from 2000-7400 hg cm^{-2}. A hand-drawn vertical depth intensity curve drawn through data points of other workers is also used as a datum. It is found that to fit the Utah data one must assume that the average fractional energy transfer per g cm^{-2}, b_{tot}, is increasing over the energy range studied. It is assumed that the increase reflects an increasing photonuclear cross section. No functional dependence of b_{tot} with energy is given, but effective values of b_{tot} as functions of depth are plotted. It is estimated that, independent of the value of b_{tot} taken, the ratio of new process muons to pions of the same energy, at production, is 2 percent ± 1 percent. The calculated muon spectrum is compared with spectra predicted by a variety of independent experiments and is found to be in good agreement. (Diss. Abstr.)

Strong (Baryon-Induced)

Refer also to abstracts 39744 and 39935.

39605 (ORO-2504-142) INVESTIGATIONS ON THE PROPERTIES OF K MESONS AND HYPERONS AND RELATED TOPICS IN HIGH ENERGY PHYSICS. Progress Report, October 1, 1968-September 30, 1969. Technical Report No. 70-004. (Maryland Univ., College Park. Dept. of Physics and Astronomy). July 1969. Contract AT(40-1)-2504. 48p. Dep. CFSTI.

Research on the fundamental properties of elementary particles and their properties is reviewed. Kaon and hyperon interactions and properties are studied primarily. The progress of the experimental counter-spark chamber program, the bubble chamber and theoretical program, and PEPR project status are reviewed. A list of publications under AEC contract is given. (J.F.P.)

39606 MULTIPLE PARTICLE PRODUCTION IN PROTON-NUCLEON INTERACTIONS AT 22.6 AND 24 GeV/c. Hasegawa, Shun-ichi (Waseda Univ., Tokyo); Nanjo, Hirotada; Ogata, Takeshi; Sakata, Michinori; Tanaka, Kojiro; Yajima, Nobuo. Progr. Theor. Phys. (Kyoto), 41: 675-85(Mar. 1969).

The analysis of inelastic interaction of 22.6 and 24 GeV/c proton with free or quasi-free nucleon is made for the events, with $N_h \leq 1$ and $K_M \leq 1.4$, which were measured. The observed angular distribution is asymmetric in the forward and backward directions in the center of mass system and is interpreted as being distorted owing to the secondary interactions of the emitted particles in the emulsion nucleus. In order to analyze the experimental data without suffering from this undesirable effect, the events are classified by the degree of asymmetry in the angular distribution. The results suggest, less depending on the multiplicity, the existence of the a priori angular distribution such that the multiple particle production process occurs through the production of the center which emits particles in an isotropic way in its rest system. A possible interpretation of the center of emission is presented. (auth)

Strong (Meson-Induced)

Refer also to abstract 39605.

39607 (AD-687143) STUDIES OF RESONANT STATES OF ELEMENTARY PARTICLES AND HYPERNUCLEI. Final Report. Setti, Riccardo Levi (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies). Apr. 21, 1969. Contract AF49(638)-1652. 12p. (AFOSR-69-1151-TR). CFSTI.

The results of a resonance formation experiment in the negative kaon-proton system between 800 and 1200 MeV/c lab. momentum are summarized. A study of antikaon-N yields antikaon-N has provided evidence for the formation of at least five resonant states in this interval, and determination at their quantum numbers. A new and precise determination of the decay branching fractions of lambda hyperon (1520) has been performed. A phenomenological model combining diffractive and resonant amplitudes was developed to explain the behavior of the negative kaon-proton yields negative kaon-proton differential cross sections in the region investigated. The momentum dependence of the slope of the forward exponential peak in several meson-baryon elastic scattering processes was studied and interpreted. (USGRDR)

39608 (CEA-R-3579) CONTRIBUTION TO π^+p INELASTIC SCATTERING AT INCOMING PION ENERGIES NEAR 1 GeV. Deler, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1969. 103p. (In French). Dep.

Thesis. Submitted to Paris Univ., Orsay, France.

Results on π^+p scattering at 810 and 1300 MeV incoming kinetic energy are presented. In the three-body final states ($\pi^+p \rightarrow \pi^+\pi^0p$ or $\pi^+\pi^+n$) the N^*_{33} production is strongly dominant. At 1300 MeV one also observes the ρ, $N^*_{3,3}$ and $N^*_{3,1}$ productions. The difficulty in correctly separating these channels demands trying a more general analysis, taking simultaneously into account several processes ($N^*\pi$, ρN, ...). A generalized isobaric model is discussed. Assuming the interaction of particles by pairs, one can carry out a partial wave analysis of the three body final state reactions. The expansion of the differential cross section in spherical harmonics for data between 600 and 1460 MeV (compilation of data from different laboratories) leads to a simple discussion of the angular effects for different parts of the Dalitz plot. A partial wave analysis was made below 1 GeV. The reaction $p\pi^+\pi^0$ is correctly explained by considering only the N^*_{33} production. The different partial waves are in agreement with the elastic phase shift analysis, except for the wave SD1 (corresponding to

the elastic wave S31) which is found to be small. Therefore, the S31 resonance appears weakly coupled to the N^*_{33}-π channel. (auth)

39609 (COO-1428-127) ANNUAL PROGRESS REPORT, JUNE 1, 1968-MAY 31, 1969. Loeffler, Frank J. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1428. 27p. Dep. CFSTI.

Experimental research on high-energy physics at Purdue University is summarized. This research includes $K^- + d$, $\pi^+ + p$, $\pi^+ + d$, $\pi^- + p$ interactions, and the $\pi\pi$ phase shift analysis. A list of publications and papers in process is appended. (J.F.P.)

39610 (UCR-34-P-107-84) ANNUAL REPORT [ON HIGH-ENERGY EXPERIMENTAL PHYSICS]. Kernan, A.; Poe, R. T. (California Univ., Riverside). May 1969. Contract AT(11-1)-34. 24p. Dep. CFSTI.

Progress in experimental high-energy physics research at the University of California, Riverside, for the year 1968 to 1969 is reviewed. Papers published during the year are briefly discussed and research in progress is outlined. (J.F.P.)

39611 (UCRL-18863) PROPERTIES OF THE η' MESON. Rittenberg, Alan (California Univ., Berkeley. Lawrence Radiation Lab.). June 4, 1969. Contract W-7405-eng-48. 128p. Dep. CFSTI.

Thesis.

The $\eta'(958)$ meson was studied in the reaction $K^-p \rightarrow \Lambda\eta'$, with K^- beam momenta ranging from 1.70 to 2.65 GeV/c. The Dalitz plots of η' decay into $\pi^+\pi^-\eta$ and $\pi^+\pi^-\gamma$ were examined, and from them it was determined that the most likely quantum numbers of the η' are $I^GJ^P = 0^+0^-$, although $J^P = 2^-$ cannot be completely ruled out. It was also shown that the decay into $\pi^+\pi^-\gamma$ is mediated by the decay $\eta' \rightarrow \rho^0\gamma$. An examination of the production process has yielded further evidence for the $J^P = 0^-$ assignment and suggested that the process takes place via $K^*(891)$ exchange in the t channel. Branching fractions and cross sections were determined, and finally a search for a negatively charged η' in the deuterium reaction $K^-d \rightarrow p\Lambda\eta'^-$ has confirmed that I = 0 assignment for the η'. (auth)

39612 (UCRL-19225) THE $\phi\omega$ AND $\eta\eta'$ PRODUCTION RATIOS IN THE REACTION $\pi^+p \rightarrow \Delta^{++}$ + BOSON AT 3.7 GeV/c. Butler, W. R.; Coyne, D. G.; Goldhaber, G.; Hall, B. H.; MacNaughton, J. N.; Trilling, G. H. (California Univ., Berkeley). June 1968. Contract W-7405-eng-48. 12p. (CONF-690608-4). Dep. CFSTI.

From International Conference on Elementary Particles, Lund, Sweden.

In a high-statistics experiment with π^+p at 3.7 GeV/c using a hydrogen bubble chamber the suppression of the reaction $\pi^+ + p \rightarrow \Delta^{++} + \phi$ relative to the reaction $\pi^+ + p \rightarrow \Delta^{++} + \omega$ is found. A cross section ratio of $0.0015^{+0.0022}_{-0.0013}$ is obtained. However, the K^+K^- spectrum indicating ϕ production gives no indication that ϕ production occurs in association with Δ^{++}. The reaction $\pi^+ + p \rightarrow \pi^+ + \phi + p$ appears to be a nonperipheral process leading to three particles in the final state. The $\omega\phi$ mixing angle is also obtained. Also in this experiment the reactions $\pi^+ + p \rightarrow \Delta^{++} + \eta$ and $\pi^+ + p \rightarrow \Delta^{++} + \eta'$ are studied. The ratio of $\Delta^{++}\eta$ events to $\Delta^{++}\eta'$ is found to be 4.7 ± 1.3, and the η/η' mixing angle is evaluated. (J.F.P.)

39613 (UCRL-19229) FURTHER STUDY OF THE H(990) EFFECT. Goldhaber, G.; Butler, W. R.; Coyne, D. G.; Hall, B. H.; MacNaughton, J. N.; Trilling, G. H. (California Univ., Berkeley. Lawrence Radiation Lab.). June 1969. Contract W-7405-eng-48. 15p. (CONF-690608-5). Dep. CFSTI.

From International Conference on Elementary Particles, Lund, Sweden.

An exposure of 180,000 pictures of the hydrogen bubble chamber to a 3.7-GeV/c π^+ beam was made. It is found that in a sample of 17,082 $\pi^+ + p \rightarrow \pi^+ + \pi' + \pi^0 + \pi^+ + p$ events without ρ selection and after allowing for the $\eta' \rightarrow \pi\pi\gamma$ decay mode there is a small but distinct residual effect called h(1000). Also the h(1000) effect shows up clearly primarily outside of the Δ^{++} band. To interpret the observed effect a quantitative comparison is made between η' production and the H effect. It is noted that the H(990) effect is not observed. (J.F.P.)

39614 DIFFRACTION GENERATION OF PIONS ON CARBON NUCLEUS WITH π-MESONS WITH 7.5 GeV/C MOMENTUM. Abdullaeva, K. N.; Azimov, S. A.; Azimova, M.; Gulyamov, U. G.; Prozorova, E. I.; Rizaev, Kh. A.; Yuldashev, A. A. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 2, 17-19(1969). (In Russian).

Dissociation of π^-meson into three charged pions in a carbon nuclear field af 7.5 GeV/c was studied with a 24-liter propane bubble chamber. The selected 350 stars without black tracks and three secondary forward tracks were studied with microscopes and IBM computers. The cross section of diffraction generation of charged pions in a carbon nuclear field at 7.5 GeV/c was found to be (280 ± 70) μbarn. (R.V.J.)

39615 SOME ASPECTS OF THE REACTION $\pi^-p \rightarrow n\pi^+\pi^-$ AT 11 GeV/c. Caso, C. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa); Conte, F.; Benz, P.; (and others). Nuovo Cim., 62A: 755-75(Aug. 1, 1969).

An analysis of 1268 $\pi^-p \rightarrow n\pi^+\pi^-$ interactions obtained in the 1.5 m BNHBC and in the 2 m CERN HBC exposed at the CERN proton synchrotron to a π^- beam of 11 GeV/c momentum is presented. The total cross section of this channel is evaluated to be $\sigma = (0.7 \pm 0.1)$ mb, while the production cross sections for the ρ^0, f^0 and g^0 resonances are determined as $\sigma_{\rho^0} = (110 \pm 14)$ μb, $\sigma_{f^0} = (75 \pm 14)$ μb, $\sigma_{g^0} = (55 \pm 14)$ μb. Some experimental behavior of the ρ^0 production is compared with the predictions of the OPE model with Dürr-Pilkuhn form factors, the OPE absorptive model, the Regge model and the absorptive Regge model. (auth)

39616 $\pi^- + p \rightarrow K^0 + \Lambda/\Sigma^0$ ASSOCIATED PRODUCTION IN THE FORWARD DIRECTION AT 6, 8, 10, AND 11.2 GeV/c. Bertolucci, E.; Mannelli, I.; Pierazzini, G.; (and others) (Univ., Pisa, Italy. Istituto Nazionale de Fisica Nucleare, Pisa, Italy). Nuovo Cim., Lett., 2: 149-55(Aug. 1, 1969).

The final results on measurements of the forward differential cross section for the reaction $\pi^- + p \rightarrow K^0 + \Lambda/\Sigma^0$ at 6 to 11.2 GeV/c using an optical spark chamber system are presented. Also the ratio $R(\Lambda/\Sigma^0)$ at 11.2 GeV/c of the cross sections integrated over the forward peak is estimated. (J.F.P.)

39617 SEARCH FOR A POSSIBLE I = 0, Y = 0 BARYON IN $\bar{K}^-d$ INTERACTIONS AT LOW ENERGY. Tan, Tai Ho (Stanford Linear Accelerator Center, Calif.). Phys. Rev. Lett., 23: 101-3 (July 14, 1969).

An attempt has been made to detect possible existence of a new neutral hyperon by studying both the missing-mass system and the $\Lambda\gamma$ system. The result does not warrant the necessity of introducing any new hyperon near the mass of Λ, although it is not sensitive enough to dismiss the possibility entirely. (auth)

39618 VENEZIANO AMPLITUDE: INTERFERENCE MODELS AND ARGAND LOOPS. Coulter, Philip W.; Ma, Ernest S.; Shaw, Gordon L. (Univ. of California, Irvine). Phys. Rev. Lett., 23: 106-9(July 14, 1969).

In the Veneziano model, at large s and fixed t, the s-channel resonances sum to give $\Gamma(1 - \alpha(t))(-s)^{\alpha(t)-1}$ and the u-channel resonances sum to $\Gamma(1 - \alpha(t))s^{\alpha(t)-1}$. Using this feature, a new interference model for intermediate energies which gives a significantly improved fit to the backward π^-p data is proposed, and comments are made on the Schmid Argand loops. (auth)

39619 YADERNYE VZAIMODEISTVIYA PRI VYSOKIKH ENERGIYAKH. (Nuclear Reactions at High-Energies). Tbilisi, USSR, Izdatel'stvo Metsniereba, 1969. 138p.

Thirteen articles are included on high-energy nuclear reactions. Cross sections of interactions between 10^{11} eV cosmic particles with iron nuclei are described. Effects of statistical errors, made during measurements of mean free paths of nuclear-active particle interactions are analyzed. Properties of penetrating cosmic radiation at 200 m water, the angular μ-meson distribution at 10^{11} to 10^{12} eV and electron-photon showers are discussed. The shower cascade theory, distribution of particles in electromagnetic showers, and the process of K^0_2-meson interactions with Cu and Pb nuclei are covered. The Tskratskaro installation for studying high-energy cosmic particle interactions with solids, spark calorimeters, and a discharge-condensing chamber used for elementary particle track detection are described. The design and performance of an overcompression metric Wilson chamber and the memory on a magneto striction tape with functional amplification of measured amplitudes are described. (R.V.J.)

39620 $\pi^- + p$ ELASTIC SCATTERING NEAR .893 AND 1.03 BeV/c. Dawes, William Redin Jr. Tucson, Ariz., Univ. of Arizona, 1968. 42p.

Thesis.

Fluctuations observed in the cross sections of low energy nuclear scattering experiments were successfully explained by as-

suming the reaction is dominated by a statistical process. This experiment examined the $\pi^- + p$ elastic scattering reaction at five incident pion momenta ranging from 1.02 to 1.06 GeV/c to determine if there were any fluctuations that could be explained by a statistical process. Within the errors of the experiment, no fluctuations of this nature were observed. Spark chambers were used to determine the differential cross section over the angular range of $-.2 < \cos\theta^* < .8$ where θ^* is the center-of-mass scattering angle. Of the 1,800 elastic scattering events measured at a nominal momentum of 1.03 GeV/c, 1,030 had their incident pion momenta determined to .1%. Two hundred occurred in the angular region of $.05 < \cos\theta^* < .45$, which is outside the forward diffraction peak and in a region where corrections due to geometrical biases were not required. These events were grouped into five momentum bins and examined for fluctuations over small changes in incident pion momenta. Six hundred $\pi^- + p$ elastic scattering events were measured at .893 GeV/c to determine geometrical biases and to confirm the normalizations and corrections used. (Diss. Abstr.)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 39291.

39621 EXACT SOLUTION OF THE N-PARTICLE SCHROEDINGER EQUATION WITH TWO-PARTICLE HARMONIC INTERACTIONS. Almstroem, H. (Royal Inst. of Tech., Stockholm). Nuovo Cim., Lett., 1: 817-19(June 1, 1969).

The N-particle Schroedinger equation is solved for arbitrary parameters. From the solutions, solutions are constructed with appropriate symmetries. The model can be used for a nucleus and quarks. The wave function for helium-2 is given. (J.F.P.)

General

Refer also to abstracts 39789, 39798, 39834, 39838, 39852, and 40159.

39622 (COO-1428-133) ANNUAL PROGRESS REPORT, TASK B, JUNE 1, 1968-May 31, 1969. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1428. 28p. Dep. CFSTI.

Theoretical research on high-energy physics at Purdue University is summarized. This research includes particle interactions and production, resonances, particle decay, and scattering. (J.F.P.)

39623 CLIFFORD ALGEBRA AND MASSLESS PARTICLES. Santhanam, T. S.; Chandrasekaran, P. S. (Inst. of Mathematical Sciences, Madras). Progr. Theor. Phys. (Kyoto), 41: 264-8(Jan. 1969).

It is shown that an equation of a spin-half particle involving a complete set of mutually anticommuting (2n + 1) matrices furnishing the representation of Clifford algebra C_n of order 2^n can be reduced to the ordinary Dirac form involving only four anticommuting matrices when the particle is massive; in the case of massless particles it reduces to an equation involving five anticommuting matrices one occurring in a singular idempotent combination with the unit matrix. It is further shown that the above two forms are connected by a singular idempotent operator. (auth)

39624 FUNCTIONAL MANIFOLD AS A BASIS OF PHYSICAL FORMULATION. Azuma, Shuko (Fukushima Univ., Japan). Progr. Theor. Phys. (Kyoto), 41: 271-3(Jan. 1969).

A modification of the superposition principle of quantum mechanics was suggested to satisfy the requirement for the existence of a limit in the accuracy of measurement of length. A complex functional manifold which is not linear and the Hilbert space composed of the set of fields on this manifold are introduced. The kind of physical interpretation possible for the manifold and the Hilbert space is discussed. (L.B.S.)

39625 LIMIT FOR MEASUREMENT OF LENGTH AND QUANTUM THEORY. Azuma, Shuko (Fukushima Univ., Japan). Progr. Theor. Phys. (Kyoto), 41: 269-71(Jan. 1969).

Some arguments for the existence of a limit to the accuracy of a measurement of length are given on empirical grounds. The question of whether the basic scheme of quantum theory satisfies the empirical requirement is considered. (L.B.S.)

39626 PRIMER CONGRESO LATINO-AMERICANO DE FISICA, OAXTEPEC, MOR., 29 JULIO-3 AGOSTO 1968. (First Latin-American Congress on Physics, July 29-August 3, 1968, Oaxtepec, Morelos, Mexico). Rev. Mex. Fis., 17: 70-141(1968). (CONF-680719).

Abstracts of papers presented at the congress in the fields of theoretical physics, elementary particles and field theory, nuclear physics, solid state physics, atomic and molecular physics, geophysics, space physics, astrophysics, physics education, general physics, statistical mechanics, and many-body problems are included. (C.E.S.)

39627 GEOMETRY OF RELATIVISTIC n PARTICLE INTERACTIONS. Arens, Richard; Babbit, Donald G. (Univ. of California, Los Angeles). Pac. J. Math., 28: 243-74(Feb. 1969).

Several mathematical versions of what might be understood by the term relativistic n particle interactions are investigated. The present treatment involves the idea that for each observer there is a separate phase space. There is no natural geometric way to identify these phase spaces with each other. The central problem emerges of organizing the various correspondences which arise between phase spaces. There are 2 conceptually distinct classes of such correspondences, the kinematic and the dynamic. Several mathematical versions of n particle interaction are presented to define what is meant by the relativistic invariance of an interaction, rather than limit the discussion to such invariant interactions ab initio. The most obvious version of an n-particle interaction is that in which an interaction is characterized by the class of n-tuples of world lines to which it gives rise. The second version emphasizes the dynamic correspondence between the phase spaces of all pairs of Lorentz observers to which the interaction gives rise. In this case there arises a family of transformation U(g), g ranging over the Poincare group, in the phase space of any one observer. Relativistic invariance is characterized by the functional equation $\overline{U(g,g')} = U(g)U(g')$. An interaction in the second sense gives rise to n-tuples of world lines and to an interaction in the first sense (and conversely). Invariance, if any, is passed from one to the other. In the third version what takes place in the phase space of one observer is described and conditions are discovered ensuring that this local action can be extended to produce the type of dynamic correspondence between all the phase spaces as required by the second version. This third version, in as much as it involves only one phase space, is susceptible to an infinitesimalization in which actions of groups are replaced by actions of Lie algebras. (BBB)

39628 IS INTERACTION POSSIBLE WITHOUT HEREDITY? Droz-Vincent, Ph. (Institut Henri Poincare, Paris). Nuovo Cim., Lett., 1: 839-41(June 1, 1969).

It is considered whether nonhereditary relativistic dynamics is at least conceptually possible for interacting points. It is only required that the systems sought for are causal in the sense of the initial data problem. (J.F.P.)

39629 SHELL THEORY OF ELEMENTARY PARTICLES. Akulov, N. S. Dokl. Akad. Nauk BSSR, 13: 492-7(June 1969). (In Russian).

Various analyses of the quantum field theory showed that all interaction forces in elementary particles and nuclei have electromagnetic properties, and types of particles with rest mass varying from zero are constructed of electrons and positrons. Studies of interactions based on secondary quantization resulted in renormalization of the mass and charges. The mass of quasiparticles was determined and the problem of determining the numbers and saturation of quantum levels in elementary particles was resolved. It is shown that it is possible to find, theoretically, the decay modes of elementary particles and determine their mass without using arbitrary constants. (R.V.J.)

39630 PARTIAL-WAVE EXPANSION IN THE CROSSED CHANNEL FOR SCATTERING AMPLITUDES INVARIANT UNDER THE GALILEI GROUP. Gervais, J. L.; Velo, G. (New York Univ.). J. Math. Phys. (N. Y.), 10: 1265-70(July 1969).

A partial-wave analysis in the crossed channel is performed for a Galilean-invariant scattering matrix using the irreducible unitary representations of the Euclidean group in two dimensions. As in the relativistic case, a formula is obtained which is useful in determining the high-energy behavior of the scattering amplitude for fixed-momentum transfer. In particular, the Born term is shown to correspond to a δ function in this representation. Moreover, this parametrization is related by a group contraction to the corresponding background term of the relativistic case. (auth)

39631 FINITE- AND INFINITE-COMPONENT FIELDS AND EQUATIONS GENERATED FROM THE DIRAC EQUATION. Palev, C. D. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim., 62A: 585-603(July 21, 1969).

A method is presented which allows one to regard classes of finite- and infinite-component wave equations from a unique point of view. The equations of a given class appear as different forms of one generalized equation. With the help of a well-defined automorphism the equations may be obtained from one another. In this way it is possible to generate a set of finite as well as infinite component equations from a given one. An example is given with the Dirac equation. (auth)

39632 WHERE ARE TACHYONS? Peres, A. (Israel Inst. of Tech., Haifa). Nuovo Cim., Lett., 1: 837-8(June 1, 1969).

It is shown that tachyons cannot be localized at all. Their position operator is not self-adjoint and has no self-adjoint extension. It is therefore not observable. (J.F.P.)

39633 HYPERPLANE HELICITY STATES. McDonald, S. C. (Ames Lab., Iowa). J. Math. Phys. (N. Y.), 10: 1234-40 (July 1969).

The hyperplane formalism of Fleming is developed to include a discussion of the operations of the Poincaré group, as seen by an arbitrary hyperplane observer. Basis states for the $m > 0$ irreducible representations of the Poincaré group are re-expressed within the framework of generalized covariance provided by the hyperplane formalism and are seen to be related to the conventional helicity states by a special Lorentz transformation. (auth)

39634 CAUSALITY AND SPACE-LIKE SIGNALS. Bilaniuk, O. M. (Swarthmore Coll., Pa.); Sudarshan, E. C. G. Nature (London), 223: 386-7(July 26, 1969).

A proof is presented that the sign reversal of the time interval between two events, such as the emission and absorption of a particle or signal, is necessarily accompanied by sign reversal of the corresponding energy. It is also shown that a faster-than-light meta-particle (tachyon) need not violate causality. Any particle or signal propagating "backwards in time" in a reference frame S' carries negative energy in S', which means that, for the observer in S', it is a positive energy particle or signal propagating forward in time. This reasoning is referred to as "the reinterpretation principle." This principle also provides the key to the understanding of negative energies of space-like particles or signals, and is the crux of any consistent theory of faster-than-light particles. The reinterpretation is "antiparallel" to the Stückelberg–Feynman view of positrons as negative energy electrons travelling backwards in time. (UK)

39635 INTRODUCTION TO THE METHOD OF CURRENT ALGEBRA. Pietschmann, H. (Univ., Vienna). Ergeb. Exakten Naturwiss., 50: 53-64(1969).

The power of current algebra is demonstrated on the Alder–Weisberger relation and the Mathus–Okubo–Pandit–Callan–Treiman relation. Sum rules for spectral functions are also discussed. (J.F.P.)

39636 CURRENT ALGEBRA AND PHENOMENOLOGICAL LAGRANGE FUNCTIONS. Invited Papers presented at the First International Summer School for Theoretical Physics, University of Karlsruhe, July 22–August 2, 1968. Hoehler, G. (ed.). Springer Tracts in Modern Physics. Ergebnisse der Exakten Naturwissenschaften. Volume 50. Berlin, Springer-Verlag, 1969. 160p. DM 44,--.

Available in U. S. from Springer-Verlag, New York for $11.00.

The conference included 12 papers. Separate abstracts were prepared for all papers. (J.F.P.)

For abstracts of individual papers see: 39635, 39637, 39665, 39681–39683, 39719, 39763, 39783, and 39818–39820.

39637 CURRENT ALGEBRA AND LIGHTLIKE CHARGES. Leutwyler, H. (Univ., Bern). Ergeb. Exakten Naturwiss., 50: 29-41(1969).

The discussion of current algebra and lightlike charges covers charge algebra, infinite momentum, lightlike charges, the quark model, local transformation properties, and the Weinberg sum rules. (J.F.P.)

39638 THE TIME OF ARRIVAL IN QUANTUM MECHANICS. II. THE INDIVIDUAL MEASUREMENT. Allcock, G. R. (Univ. of Liverpool). Ann. Phys. (N. Y.), 53: 286-310(June 15, 1969).

It is first shown that the time at which a moving classical particle reaches a fixed space point can be measured with arbitrarily high precision by the use of a suitably conceived apparatus. The same apparatus is then imagined to be exposed to a moving nonrelativistic quantum particle. Von Neumann's theory of quantum measurements is adapted to cover cases like this, in which pieces of information from the measurement process accumulate in the registration stages of the apparatus over an extended period of time. The relevant Schrödinger equation is solved. It is found that the apparatus fails to fulfill its designed purpose if its resolution time is too small. This implies an extension of the uncertainty principle and of the principle of complementarity—there are dynamical variables in classical particle mechanics which even singly admit no perfectly defined quantal counterparts. The status of the particle concept in the interpretation of nonrelativistic quantum mechanics is discussed in the light of these findings. (auth)

39639 THE TIME OF ARRIVAL IN QUANTUM MECHANICS. III. THE MEASUREMENT ENSEMBLE. Allcock, G. R. (Univ. of Liverpool). Ann. Phys. (N. Y.), 53: 311-48(June 15, 1969).

A discussion is given of the phenomena and problems of interpretation which arise when a nonrelativistic quantum particle falls upon an apparatus designed to measure the time of its arrival at a fixed spatial point. Good measurement at finite resolution for the gamma ray microscope, the fictitious arrival-time distribution limitations on the statistical concept of arrival time, and the probability current are discussed. The uncertainty relation between energy and time is written in a modified form in order to take account of the extra uncertainty inherent in the statistical arrival-time concept. The statistical concept of time delay in scattering processes is also examined. It is shown that the statistical concept of time delay can be measured with complete precision in an ensemble of arrival-time experiments even though the corresponding arrival-time probability distributions can only be inferred approximately and with finite time uncertainty. (J.F.P.)

39640 THE TIME OF ARRIVAL IN QUANTUM MECHANICS. I. FORMAL CONSIDERATIONS. Allcock, G. R. (Univ. of Liverpool). Ann. Phys. (N. Y.), 53: 253-85(June 15, 1969).

It is argued that the complementarity of time and energy in one-dimensional wave mechanics finds its proper application in the measurement of the time at which a moving particle arrives at (or departs from) a fixed spatial point. A rigorous proof is given that the ordinary Hilbert space of a freely moving particle does not contain a set of measurement eigenstates for this measurement problem. The proof depends upon the semi-infinite extent of the energy spectrum. Both this result and the physical nature of an arrival-time situation suggest that the most suitable and general wave function for the problem might be obtained by arranging that the particle be emitted by a source situated at a finite distance from the point of detection. Such sources are introduced, and the motion over the intervening space is treated by using the one-dimensional nonrelativistic Schrödinger equation. The resultant free-particle wave functions contain components with both positive and negative energies, and constitute a linear space different from the ordinary Hilbert space. The arrival-time problem then becomes one of interpreting these unfamiliar wave functions, with a view to obtaining a formula for the arrival probability per unit time. It is proved with complete generality and rigor that this modified problem also has no solution. The mathematical properties of the time-dependent Schrödinger equation make it impossible to construct any operationally meaningful and apparatus-independent probability formula. This demonstrates the existence of genuine measurement problems which lie beyond the scope of the usual measurement formalism. Such problems can only be satisfactorily discussed by making reference to the mechanical parameters of the measuring apparatus. (auth)

39641 QUANTUM THEORY AND ELEMENTARY PARTICLES. Weisskopf, Victor F. (Massachusetts Inst. of Tech., Cambridge). pp 193-214 of Atome, Kerne, Elementarteilchen. Suessmann, Georg; Fiebiger, Nikolaus (eds.). Frankfurt am Main, Umschau Verlag, 1968. (In German).

The contribution of quantum theory to the understanding of elementary particles is described with a consideration of the baryon and the meson spectrum. The guarantee of stability by baryons is considered. SU(3) and SU(6) symmetries are discussed. Weak interactions are briefly considered. (J.S.R.)

39642 DYNAMICS OF ELEMENTARY PARTICLES. Duerr, Hans Peter (Max-Planck-Institut fuer Physik und Astrophysik, Munich). pp 229-44 of Atome, Kerne, Elementarteilchen. Suessmann, Georg; Fiebiger, Nikolaus (eds.). Frankfurt am Main, Umschau Verlag, 1968. (In German).

The difficulties in the determination of the dynamics of elementary particles are outlined. The concept of causality is defined and its consequences are discussed. Relativistic causality is then considered. The field concept in elementary particle dynamics and the contribution of quantum mechanics and field theory are considered. The relation of quantization and causality is discussed. The dynamic theory in strong interactions is given. A unified theory of elementary particles is considered. (J.S.R.)

Electromagnetic

Refer also to abstracts 39598, 39802, 39824, and 40103.

39643 (COO-264-490) SPIN 1 ELECTRODYNAMICS WITH AN ELECTRIC QUADRUPOLE MOMENT. Aronson, Harmon (Chicago Univ., Ill.). Apr. 1969. Contract AT(11-1)-264. 34p. (EFI-69-31). Dep. CFSTI.

Thesis.

The quantum theory of the electromagnetic interactions of a charged, spin-1 particle is investigated within the framework of canonical field theory. An earlier treatment of this problem by Lee and Yang is generalized so as to include an arbitrary quadrupole moment. Some difficulties connected with the lack of relativistic covariance of the theory can be overcome, without using Lee and Yang's "ξ-limiting formalism," provided one allows for direct scattering among the charged particles. (auth)

39644 (ITF-69-38) WHAT ARE RANGE AND TIME OF HIGH-ENERGY INTERACTION OF PARTICLES? Lendel, A. I.; Lomsadze, Yu. M.; Tokar, S. S.; Chizhikov, V. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 11p. (CONF-690417-9). Dep.

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

It is shown that in the expression for the amplitude of bremsstrahlung of arbitrary number of soft photons through the main-reaction amplitude the first derivatives of this amplitude with respect to mass of scattering particles are absent for any relation between the energies of photons. A new method is proposed for obtaining experimental information about the effective space-time regions $\sigma^1(s)$ and $\phi^0(s)$ of the particle interaction at high energies. The method is based on experimental studying of the ratio $d\sigma_\gamma/d\sigma$ of the differential cross section of the bremsstrahlung reaction to the differential cross section of the main reaction at large s in a certain region of the variation of t. (auth)

39645 (LNF-69/25) A MODEL WITH LINEARLY RISING REGGE TRAJECTORIES FOR THE ISOVECTOR NUCLEON FORM FACTOR. Note No. 441. Di Vecchia, P.; Drago, F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Apr. 28, 1969. 8p. Dep.

A model for the isovector form factor of the nucleon is proposed in analogy with the Veneziano model for scattering amplitudes. The agreement with the experimental data is quite good and provides additional evidence for the linearity of the Regge trajectories up to $t = -25$ (GeV/c)^2. (auth)

39646 THE p-n MASS DIFFERENCE BASED ON THE REGGEIZED TADPOLE MODEL. Miura, Kimio; Watanabe, Tsunetoshi (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto), 41: 568-70(Feb. 1969).

The p-n mass difference was investigated assuming Regge asymptotic behavior and using generalized superconvergence relations. The result $\Delta m(p-n) \geq 0.45$ gives the wrong sign. (L.B.S.)

39647 BREMSSTRAHLUNG FROM HADRONIC DECAYS OF HYPERONS. Ponomarev, L. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 9: 1236-44 (June 1969). (In Russian).

The matrix element for the decay $Y \to N\pi\gamma$ is expanded in the power series over the γ-quantum momentum k. The γ spectra for the reactions are calculated with account of two lower terms of the order k^{-1} and k^0. It is shown that the contribution from the magnetic moments to the spectrum is, in general, larger than that from the interference of the charge radiation with the direct emission which is unknown. A kinematic suppression of the charge radiation is proposed to extract the contribution from the magnetic moments (the proposition is to observe the γ quants emitted at angles of about 180° to the momentum of the charged π meson). (auth)

39648 LOW ENERGY LIMIT OF PHOTOPION-PRODUCTION AMPLITUDES IN CHIRAL DYNAMICS. Hosoda, Masataka; Ozaki, Kazuhiko (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 41: 145-52(Jan. 1969).

In order to understand more deeply the dynamical basis of current algebra, the low energy limit of the amplitudes for photopion-production is re-examined by expanding the nonlinear phenomenological Lagrangian in powers of coupling constant and by calculating all graphs which have a topological structure of trees. In addition to Adler's consistency conditions, the low energy theorem of the amplitudes are obtained for S-, P- and D-wave productions of the final pion. The differential cross sections at threshold are also enumerated for $\gamma p \to \pi^+ n$, $\gamma n \to \pi^- p$, $\gamma p \to \pi^0 p$ and $\gamma n \to \pi^0 n$. These are compared with the experimental data. (auth)

39649 A POSSIBLE MECHANISM OF DIRECT PRODUCTION OF MUON PAIRS AT HIGH ENERGIES. Hayakawa, Satio; Kikuchi, Ken (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 41: 570-1(Feb. 1969).

It is pointed out that the production of muon pairs is inherent to high energy nuclear interactions which take place through complex intermediate states that may be called fireballs. The process proposed is analogous to the electron pair emission from a nucleus. The pair emission width and direct muon pair cross section are calculated. The cross section for meson production by high energy muons is also calculated. (L.B.S.)

39650 REMARK ON THE FORM FACTOR IN THE FERMI QUARK MODEL. Meyer, R. F. (DESY, Hamburg). Nuovo Cim., Lett., 2: 76-8(July 11, 1969).

It is shown that one can get nucleon form factors without zeros from an antisymmetric quark wave function. Therefore, it is found that the arguments from form factors against the Fermi statistics of the quark are not convincing. (J.F.P.)

39651 ω AND B EXCHANGE AND π^0 PHOTOPRODUCTION ON NUCLEI. Rej, A. K. (Indian Statistical Inst., Calcutta). Nuovo Cim., Lett., 2: 57-60(July 11, 1969).

The ω and B exchange contributions to photoproduction of neutral pions on neutral targets are investigated. The calculations are made for both elastic and inelastic transitions at 160 MeV using oscillator wave functions to describe the nuclear structure and varying the nuclear-radius parameter over a range of permissible values to allow for the uncertainties associated with the structure effects. It is found that even at forward angles up to 90° the ω and B exchange contributions in all the elastic cases considered make a pronounced addition to the differential cross sections which is beyond the uncertainties due to the nuclear effects. The case of inelastic production at all angles greater than 60° is similar. (J.F.P.)

39652 RADIATION SPECTRUM OF AN ELECTRON MOVING IN A CONSTANT ELECTRIC FIELD. Nikishov, A. I.; Ritus, V. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Theor. Fiz., 56: 2035-42(June 1969). (In Russian).

The energy spectrum of a classically radiating electron moving in a constant electric field is obtained. In particular the radiation spectrum for a uniformly accelerated charge is derived. The region in which radiation with a given wave vector k is formed is determined on the charge trajectory. This permits one to choose suitable experimental conditions for observing the spectrum. (auth)

39653 EXPERIMENTAL INVESTIGATION OF TRANSITION RADIATION AND THE POSSIBILITY OF EXPLOITING IT TO MEASURE THE ENERGY OF FAST PARTICLES. Alikhanyan, A. I.; Ispiryan, K. A.; Oganesyan, A. G. (Inst. of Physics, Erevan). Zh. Eksp. Theor. Fiz., 56: 1796-1802(June 1969). (In Russian).

Results of an experimental investigation of transition radiation produced by 20 to 50 MeV electrons in the optical frequency range are presented. It is shown that when the radiation is recorded in a narrow cone along the direction of motion of the particles the radiation intensity strongly depends on the particle energy and this fact can be used for measuring particle energies. (auth)

39654 MAGNETIC MOMENTS OF NUCLEONS IN STRONG COUPLING MESON THEORY. Wakano, Masami (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 762-79(Mar. 1969).

The implications of identifying the first excited vibrational state of static pion and nucleon system to the Roper resonance, for the isovector magnetic moments of nucleons are studied with a refined form of the Pauli and Dancoff strong coupling theory. A satisfactory result is obtained when a strong attractive pion-pion interaction is introduced through the reduced effective mass of bound pions. Then the ratio of magnetic moments of the neutron and proton is computed for unitary irreducible representations with the Young tableaux (N, 0, 0), where N = 1, 3, 5 and ∞, of a group SU(4). It is 0, $-\frac{3}{5}$, $-\frac{19}{13}$ and -1. Strong coupling theory and group theoretic argument for N = ∞ give the same value (−1). (auth)

39655 γP TOTAL CROSS SECTION AT HIGH ENERGY AND QUARK MODEL. Okada, Kunihiko (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 41: 1376-8(May 1969).

It is shown that the additivity assumption gives results that are in good agreement with two recent determinations of the γP total hadronic cross sections at 3.5 to 5.4 GeV and at 7.5 GeV. (L.B.S.)

39656 WAVE EQUATIONS, MULTIPOLE SOLUTIONS, AND CHARACTERISTIC HYPERSURFACES FOR MASSLESS PARTICLES. Hajj, Jack P.; Weaver, David L. (Tufts Univ., Medford, Mass.). J. Math. Phys. (N. Y.), 10: 1185-90(July 1969).

The canonical wave equation and auxiliary conditions for a massless particle with arbitrary integral or half-integral spin s are derived from a symmetric spinor formulation. The wave equation is solved for the multipole solutions using the appropriate parity operator for each spin. Finally, the characteristic hypersurfaces

for the wave equation are derived and found to agree with that of the photon. The special cases of spins one, three-halves, and two are detailed. (auth)

39657 RADIATIVE CORRECTIONS TO THE LEPTON POLARIZATION AND TO THE RATE IN K_{13} DECAY. Benfatto, G.; Nicolo, F.; Rossi, G. C. (Univ., Rome). Nuovo Cim., 62A: 631-47(July 21, 1969).

Radiative corrections to the lepton polarization and to the rate in K_{13} decay are calculated. They are found to be very small and for the rate strongly cut-off dependent. (auth)

39658 PHYSICAL PHOTO- AND ELECTROPRODUCTION AT THRESHOLD BY CURRENT-ALGEBRA SUM RULES. Furlan, G.; Paver, N.; Verzegnassi, C. (Univ., Trieste, Italy). Nuovo Cim., 62A: 519-54(July 21, 1969).

By saturation of equal-time commutators of current algebra and field algebra, expressions for physical electroproduction amplitudes are deduced. They contain electromagnetic and axial form factors plus terms of order μ^2 (pion mass). A detailed evaluation of those corrections is discussed together with the comparison with experiments. (auth)

39659 ELECTRON GENERATION OF PIONS. Csikor, Ferenc; Montvay, Istvan (Eoetvoes Lorand Univ., Budapest). Magy. Fiz. Foly., 17: 229-45(1969). (In Hungarian).

The term "electron generation" refers to a process, in which electrons subjected to inelastic scattering by nucleons (protons) generate other particles, most often pions: $eN \rightarrow eN\pi$. It is closely related to the process of photogeneration, with the difference that the mass of the electron is not zero. For this reason, the contribution of scalar, i.e. longitudinal, photons must be taken into account. Some techniques, based on the detection of electrons in the final stage are unable to differentiate between the $e + p \rightarrow e + p + \pi^0$ and $e + p \rightarrow e + n + \pi^+$ reactions, in which protons are used as targets. Study of the photogeneration of pions is of interest for clarifying the structure of nucleons because it makes possible the determination of the electromagnetic formfactors in the matrix element. The kinematic variables and the coordinate systems used in these studies are reviewed. The theory of low-energy electron generation makes use of dispersion relations which may be derived on the basis of the Mandelstam representation; the isobar model is also used. (Review article). (TTT)

39660 PHOTOGENERATION OF MESON-BARYON RESONANCES AND STRANGE PARTICLES. Csikor, Ferenc; Montvay, Istvan (Eoetvoes Lorand Univ., Budapest). Magy. Fiz. Foly., 17: 247-62(1969). (In Hungarian).

From the energetic viewpoint, the generation of 2π occurs above a 325 MeV photon energy level. However, the generation cross section of 2π assumes noticeable values only at about 500 MeV; up to that level pion generation processes prevail. Above 500 MeV an N^* (1236) resonance may be generated. The $\gamma p \rightarrow p\pi\pi$ reaction is dominated up to a certain point by the $\gamma p \rightarrow N^{++}\pi^-$ reaction. The threshold values E_γ of the $\gamma + p$, and strange particle processes are described, reviewing the photogeneration of bosons. The photons required by the experiments are obtained by bremsstrahlung, therefore the photon energy is not known. Photogeneration of strange particles may involve Λ, Σ^0, Σ^+ as Y, generating K^+, K^+, and K^0, respectively. The differential cross section of the generation of Λ and Σ^0 exhibits strong peaks with increasing energy, indicating a peripheral mechanism, possibly a K or K^* exchange. (Review article). (TTT)

39661 FORM FACTORS IN WEAK AND ELECTROMAGNETIC INTERACTIONS. Fitelson, Michael Manyel. University Park, Pa., Pennsylvania State Univ., 1968. 109p.

Thesis.

The consequences of a modification of the one-photon-electron vertex function are explored. It was discovered that if the high energy ($-q^2 \sim (1\ BeV)^2$) behavior of the electron was such that it acquired an intrinsic anomalous magnetic moment of $10^{-3}\ \alpha/2\pi$, certain aspects of e-e and e-p scattering would be greatly affected. This effect is brought about without appreciably changing the anomalous magnetic moment induced by radiative corrections, and such that the Ward-Takahashi identity is satisfied. The effects of this modification were found to be quite striking with regard to polarization in e-p scattering and the angular dependence of the e-e differential scattering cross section. The formal solution to the algebra of currents is used to find approximate expressions for the K_{13+} decay and nucleon form factors. A good part of the low energy behavior of these form factors is explained by this approach. (Diss. Abstr.)

39662 DISPERSION THEORIES OF STRONG INTERACTIONS AT LOW ENERGY. Shirkov, D. V.; Serebryakov, V. V.; Meshcheryakov, V. A. New York, John Wiley and Sons, Inc., 1969. 372p. $19.50.

Translation of Dispersionnye Teorii Silnych Vzaimodejstvi pri Nizhich Energijach.

A survey is given of the basic concepts of dispersion relations and various approximate approaches to low-energy processes. These approaches are compared, and an analysis of the difficulties is given. The basic presentation is carried out beginning with equations for lower partial waves obtained by a differential approximation method. The pion-pion, pion-nucleon processes, pion photoproduction on pions, and the electromagnetic form factors of pions and nucleons are studied. (J.F.P.)

39663 COULOMB INTERACTION IN A FINITE STATE. Baier, V. N.; Fadin, V. S. (Novosibirsk State Univ., USSR). Zh. Eksp. Teor. Fiz., 57: 225-31(July 1969). (In Russian).

The matrix element for an arbitrary process taking into account Coulomb interaction between charged particles with small relative velocities in the final (or initial) states is found by direct summation of contributions of the principal diagrams of perturbation theory. (auth)

39664 PRODUCTION OF A PAIR OF PARTICLES WITH THE SPIN 2 IN COLLIDING ELECTRON-POSITRON BEAMS. Shakhnazaryan, Yu. G. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 400-7(1968). (In Russian).

The production of particles with spin 2 in the annihilation of electron-positron pairs is theoretically considered. An expression for the differential cross section in the general case of arbitrarily polarized leptons is obtained. Some particular cases of initial pair polarizations are considered also. Relations between the invariant and physical form factors of the particles with spin 2 are obtained. (auth)

39665 ELECTROMAGNETIC MASS DIFFERENCES. Rothleitner, J. (Univ., Innsbruck). Ergeb. Exakten Naturwiss., 50: 71-83(1969).

The shift of the energy levels of strongly interacting systems caused by the electromagnetic interaction is discussed. The problem of the nonrelativistic Coulomb shift and its solution by mass renormalization, the electromagnetic mass shift of hadrons including the Cottinghan formula and the single-particle elastic contribution to the electromagnetic mass shift are treated. Also treated are the connection between the asymptotic behavior of the Compton amplitude and equal-time commutators of the electromagnetic current, and a possible connection of the I = 1 electromagnetic mass differences with the nonleptonic weak decays. (J.F.P.)

39666 RADIATIVE THREE-NUCLEON REACTIONS. Davis, Ronald Stuart. Vancouver, B. C., Univ. of British Columbia, 1968.

Thesis.

Simplifications are sought to the formulation of the radiative three-nucleon reactions (i.e., direct capture, and partial and total photodisintegration) by means of group theory and other methods, similar to the simplifications to the three-nucleon Schroedinger equation made previously. Some useful results are derived for the S_3 group, the group of permutations of three things. In addition to the usual projection operators (e.g., Eichmann (1963)), operators are formed analogous to the operators J^2, J_z, and J_+ of the SU_2 group, and new methods of defining and generating permutation eigenfunctions, which transform according to the irreducible representations of S_3, are developed. Also, properties of the Derrick-Blatt (1958) addition coefficients which simplify their use are demonstrated, expressions are derived for permutations of product functions, a simplification is given for integration of permuted functions, and a Wigner-Eckart theorem for S_3 is derived. A new body-fixed coordinate system is derived which greatly simplifies the formation and use of Euler-angle functions. Three internal coordinate systems, each advantageous for a different problem, are defined, and their interconversions given. For each of them, necessary trigonometric formulas and expressions for integration are given. The Derrick-Blatt (1958) expansion for three-nucleon wave functions in permutation eigenfunctions is modified to take advantage of the new body-fixed coordinates, and relations between functions in the new and old expansions are derived. Expansions of bound states are discussed, and the continuum states of deuteron plus free nucleon and of three free nucleons are expanded in the new basis functions. Previous, erroneous attempts at similar expansions are discussed. The electric dipole and quadrupole and the magnetic-dipole orbital and spin-flip components of the interaction Hamiltonian representing an emitted or absorbed gamma ray are expressed in permutation-eigenfunction operators, using the long-wavelength and first-order-perturbation approximations, whose validity are discussed. Exact, closed, general forms are derived for matrix elements of the Hamiltonian in Euler-angle and spin-isospin variables, and the internal integrations are considerably simplified. Exact expressions, involving

integrals over the three internal variables, are thus derived for matrix elements of the overall Hamiltonian between completely general initial and final states. Expressions are given for the cross section in terms of the matrix elements, and further simplifications are given for some of the reactions involved. A few numerical results are given, which show that the cross section depends sensitively on the wave functions used. The application of this work to the study of nuclear structure and interactions is discussed. Three-quark states are also expressed in the new formalism. (Disser. Abstr.)

39667 CORRESPONDENCE IDENTITIES. III. CLASSICAL PATHS AND RUTHERFORD SCATTERING. Norcliffe, A.; Percival, I. C.; Roberts, M. J. (Univ. of Stirling, Scotland). J. Phys., B (London), 2: 578-89(May 1969).

In preparation for the derivation of correspondence identities for the Rutherford scattering problem, the relevant classical theory is developed. Convenient conventions for classical canonical transformations are introduced. Classical O(1,3) symmetry properties are discussed. Classically accessible and inaccessible regions of momentum space are defined and, for the latter, generalized classical paths and the corresponding action functions are obtained by analytic continuation. (auth)

39668 CORRESPONDENCE IDENTITIES. IV. THE RUTHERFORD SCATTERING IDENTITY. Norcliffe, A.; Percival, I. C.; Roberts, M. J. (Univ. of Stirling, Scotland). J. Phys., B (London), 2: 590-602(May 1969).

A complete correspondence identity is obtained for the electron–proton system, whereby the non-relativistic quantum dynamics of the system are obtained from solutions of the corresponding classical problem and their analytic continuation given in part III. The kernels of the spectral operator $I_E = \delta(E - H)$ in momentum and symmetric representation are obtained as sums over classical action functions for all non-zero real energies E. A general derivation of a scattering cross section from a spectral operator is presented, and applied to this system: the long-range distortion appears naturally. By this means and alternatively in terms of transition operators it is shown how the correct quantum-mechanical differential scattering formula follows from classical Rutherford theory. Complete correspondence identities are discussed. Quantum-mechanical barrier penetration is obtained through analytic continuation of classical action functions. A model of the system based on classical electron orbits is an improvement on the Bohr–Sommerfeld model. (auth)

39669 ELECTROMAGNETIC INTERACTIONS OF COMPOSITE SYSTEMS. Brodsky, Stanley J.; Primack, Joel R. (Stanford Univ., Calif.). Ann. Phys. (N. Y.), 52: 315-65(Apr. 1969).

Starting from Lagrangian field theory, the interaction Hamiltonian of a composite system with an external electromagnetic field is derived. Upon this basis, the theoretical foundations are the atomic Zeeman effect, with specific reference to the fine structure and Lamb shift measurements are developed. Also the Drell–Hearn–Gerasimov sum rule and the low energy theorem for Compton scattering for composite systems are explicitly verified. An essential result of the investigation is that the interaction of a loosely bound composite system with an external electromagnetic field can be well approximated by the sum of the relativistic interaction Hamiltonians appropriate to the free constituents, but that in general the nonrelativistic reduction of this Hamiltonian does not yield the sum of the corresponding free reduced (e.g., Foldy–Wouthuysen) Hamiltonians. New features of this work include an extended Salpeter equation which includes interactions with an external electromagnetic field, explicit wave packet solutions to a two-body relativistic equation, and a calculational approach to perturbation theory with composite systems in which sums over intermediate or final states precede nonrelativistic approximations. The explicit calculation of the DHG sum rule illustrates its superconvergent nature. (auth)

Weak

Refer also to abstracts 39649, 39812, 39824, and 40009.

39670 (NYO-3399-199) Ω^- DECAY. Goswami, D. N.; Schechter, J. (Syracuse Univ., N. Y. Dept. of Physics). June 1969. 27p. (SU-1206-199). Dep. CFSTI.

The Ω^- nonleptonic decays are investigated in the framework of a chiral Lagrangian model. In this way, ambiguities of extension of meson momenta to zero which are present in the current algebra approach are made explicit. It is found that these decays may possess a rather complicated structure and a discussion of approximation schemes is given which may help to explain the present experimental data. The approximation of the $\Xi 2\pi$ decay mode by $\Xi^*\pi$ is also discussed. (auth)

39671 NONLEPTONIC HYPERON DECAYS IN THE COVARIANT CHIRAL U(6) ⊗ U(6) SCHEME. Miyake, Shogo; Itabashi, Kiyomi (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 41: 166-75(Jan. 1969).

Nonleptonic hyperon decays are examined as a further test of the covariant chiral U(6) ⊗ U(6) scheme with SU(6)-representation mixing, which has been proposed in a previous paper. The main features of the results are as follows: (a) The $|\Delta I| = \frac{1}{2}$ rule is derived both for S- and P-wave amplitudes. (b) Experimental S-wave amplitudes are fairly well reproduced. In particular (1) $S(\Sigma^\pm) \approx 0$ is obtained without the K^*-pole- or any other analogous approximations, and (2), apart from certain mass-dependent factors (i.e., in the SU(3)-symmetry limit in a sense), the Lee-Sugawara relation holds for S-amplitudes. (c) As for the P-amplitudes, the scheme leads to no other definite conclusion than the above-mentioned $|\Delta I| = \frac{1}{2}$ rule (nor to definite inconsistency with data). (auth)

39672 P-WAVE DECAYS OF HYPERONS. II. Nishijima, Kazuhiko (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 41: 567-8(Feb. 1969).

It was previously shown that the characteristic features of the P-wave decays of hyperons are governed by two conditions, the symmetry condition and the singlet-octet condition. It is shown that the latter condition can be reduced to a pair of commutation relations between the effective Hamiltonian and the baryon field operator. (L.B.S.)

39673 SYMMETRY BREAKING EFFECTS IN NONLEPTONIC DECAYS OF HYPERONS. Toda, Azuma; Sakuraoka, Mitsuru (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 41: 491-9(Feb. 1969).

The symmetry breaking effects in nonleptonic decays of hyperons were examined. It turned out that if the weak spurion is confined to a unitary octet, then representations other than octet of $S_S \otimes S_W$ bring new parameters on the decay modes of Λ and Ξ particles. Among the three properties of nonleptonic hyperon decays, therefore, the formulation of one is modified by the broken symmetry S_S. Next the pole model was investigated along the same line of thought as a previous study [Prog. Theor. Phys. 39 (1968), 1289]. In particular, for the p-wave channel, it was assumed that the form of weak vertex is the divergence of vector current. The pole model reproduces fine results of the usual pole model but is free from the singularity of $1/\Delta m$ appearing in the usual one.

39674 $K \to 2\pi$ DECAYS AND DISPERSION RELATIONS. Matsuzaki, Yoshio; Shito, Okiyasu (Nihon Univ., Chiba, Japan). Progr. Theor. Phys. (Kyoto), 41: 479-90(Feb. 1969).

The purpose of this paper is twofold. The first is to show how the $\Delta I = \frac{1}{2}$ rule for $K \to 2\pi$ decays is derived according to the method used by Nishijima to explain the $\Delta I = \frac{1}{2}$ rule for hyperon non-leptonic weak decays. The selection rule results from the charge independence of the strong interaction, under the assumptions that the weak decay amplitude must satisfy the unsubstracted dispersion relation and that the weak interaction Hamiltonian is CP-invariant, and under an approximation neglecting all electromagnetic interactions. The conclusion is strongly dependent on the s-wave pi-pi phase shifts and p-wave cutoffs. The second purpose is to investigate why the violation of the $\Delta I = \frac{1}{2}$ rule arises. There the experimental ratio, $|A(K^+ \to \pi^+\pi^0)/A(K_1^0 \to \pi^+\pi^-)| = 4.6 \times 10^{-2}$, is deduced from electromagnetic corrections to absorptive parts of the dispersion relation on the basis of the assumption in which the violation is reduced to the electromagnetic origin alone. This is discussed in detail using a fictitious photon mass λ as the infrared cutoff. (auth)

39675 DYNAMICAL MODEL FOR THE NONLEPTONIC P-WAVE DECAY OF HYPERONS. Tokuda, Naoki (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 41: 153-60(Jan. 1969).

A bootstrap calculation is performed for the nonleptonic P-wave decay of hyperons. These decays can be treated as the scattering processes: spurion + baryon → pion + baryon. It is assumed that the weak interaction transforms like the sixth component of the octet. The f/d ratio for the weak interaction is obtained from the self-consistency conditions as a function of the f/d ratio for the strong interaction. P-wave amplitudes are calculated by using these f/d ratios. The results are qualitatively in agreement with experiment. It is shown that the inclusion of the effect of Roper resonance makes the results better. (auth)

39676 CURRENT-ALGEBRA PREDICTION FOR PHYSICAL WEAK PRODUCTION NEAR THRESHOLD. Paver, N.; Verzegnassi, C. (Univ., Trieste, Italy). Nuovo Cim., 62A: 776-90 (Aug. 1, 1969).

A prediction for the differential cross section of the process $\nu_l + n \to l^- + p + \pi^0$ at the Breit threshold is given saturating a current-algebra equal-time commutator in the Breit frame of the

two nucleons. Owing to the particular choice of the process, the prediction is almost model-independent. (auth)

39677 ANALYSIS OF POSSIBLE DEVIATIONS FROM V–A THEORY OF WEAK INTERACTIONS. Kutuzova, G. B.; Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Theor. Fiz., 56: 1904-13(June 1969). (In Russian).

A weak interaction model is considered in which, for a constant V–A structure of the (e,ν_e) current, a most general expression for the (μ,ν_μ) current, including the derivatives, is employed and possible nonvanishing of the muonic neutrino mass is assumed. Expressions are obtained for the decay probability of polarized muons and also for π_{μ_3} and K_{μ_3} decays. Estimates of the constants for the interactions introduced are discussed. (auth)

39678 NON-LEPTONIC WEAK INTERACTION IN HEISENBERG'S NON-LINEAR FIELD THEORY. Segawa, Hiroshi; Yamamoto, Hiroshi (Fukui Univ., Japan). Progr. Theor. Phys. (Kyoto), 41: 801-15(Mar. 1969).

Using degeneracy of the vacuum, non-leptonic weak interaction is introduced into Heisenberg's non-linear field theory of elementary particles. No new term is added in the fundamental field equation. The theory explains the observed values fairly well. It might be understood that at the time of decay a spurion is exchanged between the particle concerned and the vacuum. (auth)

39679 WEAK INTERACTIONS AND NEUTRINOS. Faissner, Helmut (Technische Hochschule, Aachen). pp 141-64 of Atome, Kerne, Elementarteilchen. Suessmann, Georg; Fiebiger, Nikolaus (eds.). Frankfurt am Main, Umschau Verlag, 1968. (In German).

Radioactive decay is described. The neutrino hypothesis is given and the detection of the neutrino in beta decay is discussed. The discovery of the variation between left and right and the explanation of the phenomenon are considered. The neutrino experiments at CERN which illuminate strong and weak structures are briefly described. (J.S.R.)

39680 THE PROTON RECOIL SPECTRUM OF THERMAL NEUTRONS DECAYING IN VACUUM. CORRECTIONS FOR DECAY IN FLIGHT AND FINITE SPECTROMETER RESOLUTION. Nachtmann, O. (Univ., Vienna); Paul, H. Z. Phys., 226: 17-27(1969).

The decay of neutrons in an evacuated tangential reactor beam tube is considered. Due to the thermal motion of the decaying neutrons, the proton recoil spectrum in the laboratory system (z-axis parallel to the beam tube) differs from that in the cm system. This difference is calculated for a point at the beam tube exit, and expressed in terms of the average $\bar{q}_z$ and of the variance of the z-component of neutron momentum. An activation method for measuring the neutron current density J_z (which is closely related to $\bar{q}_z$) is suggested. The distortion of the spectrum by the finite resolution of an electrostatic spectrometer is also given. The results are to be used in connection with a planned measurement of the proton recoil spectrum in neutron decay. (auth)

39681 NONLEPTONIC DECAYS AND MASS DIFFERENCES OF HADRONS. Stech, B. (Univ., Heidelberg). Ergeb. Exakten Naturwiss., 50: 84-99(1969).

Nonleptonic weak interactions of hadrons are discussed. Kaon and hyperon decays are considered. Also the relation between S-wave decay amplitudes and the mass differences of hadrons, especially electromagnetic mass differences, is treated. (J.F.P.)

39682 S-MATRIX FORMULATION OF CURRENT ALGEBRA. Pilkuhn, H. (Univ., Karlsruhe, Ger.). Ergeb. Exakten Naturwiss., 50: 65-70(1969).

The S-matrix formulation of current algebra is considered covering strong interactions and weak interactions. Pion–baryon elastic scattering, the collision of two baryons with the additional scattering of a soft pion or the production of a soft pion pair, the scattering of massless pions, are discussed. Also discussed are neutron decay, the collision of a neutrino with a neutron producing an electron, a neutron, and a soft pion, and lepton weak scattering on nucleons without the production of additional hadrons. (J.F.P.)

39683 INTRODUCTION TO CURRENT ALGEBRA. Stichel, P. (Univ., Hamburg. Deutsches Elektronen-Synchrotron, Hamburg). Ergeb. Exakten Naturwiss., 50: 120-31(1969).

A brief review of the content of current algebra, its main results and role within elementary particle physics is given. SU(3) × SU(3) current algebra, the Adler–Weisberger relation, the Fubini method for obtaining a sum rule from a given current commutation relation, and low-energy theorems are covered. It is shown that the Gell-Mann current algebra is an appropriate principle for the formulation of symmetry breaking in strong interactions and universal coupling of hadron currents in weak interactions. (J.F.P.)

39684 ON THE APPLICATION OF CURRENT ALGEBRA TO WEAK INTERACTIONS. Nakagawa, M. (Nagoya Univ., Japan); Trofimenkoff, N. N. Ann. Phys. (N. Y.), 52: 293-314(Apr. 1969).

The current algebra-partially conserved axial-vector current (CA–PCAC) method is reformulated on the basis of taking a limit $k^2 \to 0$ (not $k \to 0$) on the whole amplitude. A prescription for detecting and canceling out noncovariant portions of the amplitude which come from Goto–Imamura–Schwinger terms arising from the equal-time commutator is given. This cancelation is illustrated by a calculation of the $\pi \to \mu\nu$ decay amplitude. The method is applied to nonleptonic hyperon decays and it is shown that, as far as the equal-time commutator and baryon pole terms are concerned, it yields the same results as the usual CA–PCAC method based on the limit $k \to 0$. (auth)

39685 SUBTRACTED DISPERSION RELATIONS, CURRENT ALGEBRA, AND MOMENTUM DEPENDENT K_{l4} DECAY AXIAL VECTOR FORM FACTORS. Biswas, S. N.; Dutt, Ranabir; Gupta, K. C. (Univ. of Delhi). Ann. Phys. (N.Y.), 52: 366-79(Apr. 1969).

K_{l4} decay axial vector form factors are considered within the frame of dispersion relations and current algebra. Subtracted dispersion relations are used for the form factors, the subtraction term being given by the current commutator contribution and the dispersion integrals are saturated by s, t, u channel poles. The scalar meson contributions are however not taken into account. Explicit momentum dependence of the form factors are obtained and the decay rates are found to be in good agreement with the available experimental data. (auth)

Strong (General)

Refer also to abstracts 39802, 39804, 39824, and 40104.

39686 (ITF-69-37) TOWARDS A UNITARY PHENOMENOLOGICAL AMPLITUDE OF STRONG INTERACTION. Enkovski, L. L.; Kukhtin, V. V.; Miranskii, V. A.; Shelest, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 6p. Dep.

The possibility of unitarization of the Veneziano model is investigated. While a proof of the unitarity of the Veneziano amplitude is not given, nevertheless, the estimates show that by an appropriate choice of $\alpha(s)$, an analytic function with a right-hand cut satisfying a dispersion relation with subtractions, and of the parameters, the Veneziano formula does not contradict unitarity. (J.F.P.)

39687 (RLO-1388-554) QUANTIZATION CONDITIONS FOR LINEAR AND NONLINEAR TRAJECTORIES. Coon, Darryl D. (Washington Univ., Seattle. Dept. of Physics). [1969]. Contract AT(45-1)-1388. 7p. Dep. CFSTI.

It is shown that the relation between linear trajectories of opposite normality found by Ademollo, Veneziano and Weinberg also holds for nonlinear trajectories which occur in a generalization of the Veneziano form. It is also shown that half-integer spacing of trajectories of opposite normality which are connected by pion emission is possible only if the lowest spin particle on the upper trajectory is missing. Experimentally there is a distinct absence of such particles (e.g., low-lying $\frac{1}{2}^-$ baryons and baryon resonances). (auth)

39688 (UCR-34-P-107-95) ANNUAL REPORT [ON PARTICLE PHYSICS]. Kaus, P. E.; Desai, B. R. (California Univ., Riverside). June 1969. Contract AT(11-1)-34. 107p. Dep. CFSTI.

Progress in theoretical high-energy physics research at the University of California, Riverside, is reported for the year 1968 to 1969. A publications list is included and complete copies of reprints or preprints of published research work are appended. (J.F.P.)

39689 A NOTE OF SUM RULES OF $d\sigma/dt - t_{min}$. Matsuoka, Takeo; Ninomiya, Kansuke; Sawada, Shoji (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 41: 572-4(Feb. 1969).

Several sum rules are given between $d\sigma/dt'$ of various processes from the assumption that the two-body hadron-hadron scattering is caused by rearrangement of constituent particles (sakatons) of hadrons and that spectator sakatons do not change their spin states. (L.B.S.)

39690 BARGER AND CLINE'S RULE AND BOUND STATE OF DIRAC PARTICLE. Hirooka, Masahiko (Osaka Univ.); Konisi, Gaku; Saito, Takesi. Progr. Theor. Phys. (Kyoto), 41: 161-5(Jan. 1969).

Properties of bound-state solutions of the Dirac equation are studied for a spherically symmetric potential, which is assumed to be of short range, and to behave like $c/r^{1-\epsilon}$ with $c < 0$ and $1 > \epsilon \geq 0$ near $r = 0$. It is shown that when radial parts of wave functions have no nodes, the corresponding bound states can appear only in the $J = l + \frac{1}{2}$ state, but not in the $J = l - \frac{1}{2}$ state, where J and l are the total and orbital angular momenta, respectively. This result may correspond to Barger and Cline's rule for fermion Regge trajectories. (auth)

39691 PHENOMENOLOGICAL REPRESENTATION OF HIGH ENERGY SCATTERING OF HADRONS. Shiohara, Masao (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 41: 88-104(Jan. 1969).

Experimental data on two-body and quasi two-body collisions of the high energy hadrons are analyzed in terms of the phenomenological representations for the partial wave transition amplitudes which are suggested from the K-matrix approach of the multi-channel problem and the dominance of the one-particle-exchange mechanism. It is shown that the angular distribution and the real-imaginary ratio of the forward elastic amplitudes are well represented by appropriate choice of the parameters. The form of the quasi two-body inelastic transition amplitudes is also discussed in relation to the forward peaks of the differential cross sections and the real-imaginary ratios of the amplitudes. (auth)

39692 NEW REGGE-BEHAVED FIVE-POINT FUNCTIONS. Burnett, T. H.; Schwarz, J. H. (Princeton Univ., N. J.). Phys. Rev. Lett., 23: 257-8(Aug. 4, 1969).

Formulas are derived for two new Veneziano-type five-point functions which may be appropriate for processes involving particles of certain quantum numbers. (auth)

39693 H-QUANTUM AND AN INTEGRAL LORENTZ TRANSFORMATION. Mori, Kenju (Saitama Univ., Japan); Nakamura, Hiroshi. Progr. Theor. Phys. (Kyoto), 41: 1378-9(May 1969).

A possible relation between the discrete space-time and the H-quantum is introduced. It is inferred that the high-energy hadronic reactions are described by a dynamics on a cubic lattice in space-time. (L.B.S.)

39694 HIGH ENERGY PHYSICS. VOLUME IV. Burhop, E. H. S. (ed.). Pure and Applied Physics. A Series of Monographs and Textbooks. Volume 25. New York, Academic Press, 1969. 451p.

Volume IV of High Energy Physics contains three chapters, which deal with baryon systems, meson systems, and antinucleon-nucleon interactions. A separate abstract is prepared for each chapter. (L.B.S.)

For abstracts of individual chapters see: 39710, 39711, and 39739.

Strong (Baryon No. = 0)

Refer also to abstracts 39691, 39750, and 39818.

39695 V-P-P VERTEX IN THE DYNAMICAL COMPOSITE MODEL. Kaiba, Masayuki (Nagoya Univ., Japan); Fukushima, Kunio; Hori, Shoichi. Progr. Theor. Phys. (Kyoto), 41: 182-90 (Jan. 1969).

The V(Vector meson)-P(Pseudoscalar meson)-P(Pseudoscalar meson) vertex is examined on the basis of the composite model in which the structure of mesons participating in the $V \rightarrow P + P$ decay process is considered explicitly. The basic assumptions are as follows. (a) A hadron is constructed from urbaryons which are spin $\frac{1}{2}$ fermions. (b) Internal motion of urbaryons in a hadron is non-relativistic. (c) Urbaryons are bound by a square-well potential with depth parameter V_0 and range a. (d) The interactive force is identical to the constructive force. (e) The spatial wave function of bound urbaryon system is of an exponential type. The following dynamical parameters $m \simeq 1$ GeV, $V_0 \simeq 2$ GeV, $a \simeq 1.0$ GeV$^{-1} \sim 1.2$ GeV^{-1}, $a \simeq 1.6$ GeV ~ 2.0 GeV, are obtained by comparing the experimental value of the coupling constant with the effective coupling constant G_{eff} which is obtained as a function of the parameters (the mass of urbaryon, m, the potential depth, V_0, the potential range, a, and the parameter of spatial wave function, a). (auth)

39696 NEW MASS FORMULA OF ELEMENTARY PARTICLES. Muraki, Yasushi (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 41: 473-8(Feb. 1969).

Masses of elementary particles are expressed in terms of a logarithmic function of an integer number: $M_n c^2 = -K + \xi \ln(n)$. The mass formula is interpreted in terms of a composite model and applied to an explanation of high energy interactions. (auth)

39697 BREAKING DUALITY. Mandula, Jeffrey; Weyers, Jacques; Zweig, George (California Inst. of Tech., Pasadena). Phys. Rev. Lett., 23: 266-9(Aug. 4, 1969).

A qualitative understanding of the observed pattern of Regge trajectories is obtained from approximate duality. (auth)

39698 CHIRAL-INVARIANT EFFECTIVE LAGRANGIANS AND THE B-MESON DECAY. Alles, W.; Mazzanti, P.; Salvini, M. (Univ., Bologna. Istituto Nazionale de Fisica Nucleare, Bologna). Nuovo Cim., Lett., 2: 143-8(Aug. 1, 1969).

An attempt is made to reobtain current algebra and hard pion results for the B, ω, and ϕ mesons by introducing chiral-invariant effective Lagrangians. The coupling constants, $\omega-\phi$ mixing angle, partial and total widths and branching ratio for $B \rightarrow \pi + \omega(\phi)$ decay are found. (J.F.P.)

39699 COMMENTS ON POSITIVITY CONDITIONS IN THE VENEZIANO MODEL. Fujisaki, H. (Tokyo Univ.). Nuovo Cim., Lett., 2: 41-5(July 11, 1969).

It is shown that the Veneziano model without secondary terms cannot satisfy the positivity conditions of partial-wave projections. Thus it is concluded that to avoid ghost states among the daughters secondary terms must be included in the Veneziano formula for the $\pi + \pi \rightarrow \pi + \omega$ scattering. (J.F.P.)

39700 SATURATION OF DISPERSION SUM RULES. Johnson, R. C. (Univ. of Toronto). Nuovo Cim., Lett., 2: 50-2(July 11, 1969).

The problem of saturating the kind of sum rule that expresses some quantity as a dispersion integral over a hadronic scattering amplitude is discussed. It is pointed out that high-energy contributions to dispersion sum rules can be important and that they can be estimated from finite-energy sum rules and some internal consistency checks can be applied. The processes $\pi\pi$ and πK, where there are several established resonances but no direct scattering cross section measurements, are considered. (J.F.P.)

39701 VENEZIANO AMPLITUDE AND LORENTZ POLES. Paciello, M. L.; Sertorio, L.; Taglienti, B. (Univ., Rome). Nuovo Cim., 62A: 713-21(Aug. 1, 1969).

It is shown that the s^α behavior of the Veneziano amplitude does not correspond to the existence of a simple Lorentz pole. It is shown in detail how to restore a single-Lorentz-pole dominance for which it is necessary to add infinite Veneziano satellites. This fact is valid both for the original Veneziano amplitude and for the Mandelstam modified amplitude. (auth)

39702 REGGE-BEHAVED MEROMORPHIC AMPLITUDES AND DUALITY. Oehme, R. (Univ. of Chicago). Contract AT(11-1)-264. Nuovo Cim., Lett., 2: 53-6(July 11, 1969).

It is shown that in the narrow-resonance approximation an amplitude F(s,t) cannot have complete Regge behavior in a given channel without having an infinite number of resonance poles in this same channel. These poles must have an accumulation point at infinity. They form a meromorphic part which completely determines the amplitude. By narrow-resonance approximation it is meant that F(s,t) is a meromorphic function in both variables s and t. The amplitude for $\pi^+ + \pi^-$ scattering is considered. (J.F.P.)

39703 ON POSITIVITY CONDITIONS FOR THE VENEZIANO AMPLITUDE. Nakazawa, K.; Kiang, D.; Kwok, P. Y. (Dalhousie Univ., Halifax, Can.). Nuovo Cim., Lett., 2: 61-5(July 11, 1969).

It is shown that the conditions for positivity obtained previously can easily be derived from the assumption: $\max(m,n) \leq k \leq m + n$ alone for the scattering amplitude $A(s,t) = \gamma\, \Gamma(m-\alpha_s(s))\, \Gamma(n-\alpha_t(t))/\Gamma(k-\alpha_s(s)-\alpha_t(t))$ for identical bosons by using the Froissart-Gribov representation for the partial-wave amplitude continued to the l-plane. (J.F.P.)

39704 PRESENT EXPERIMENTAL SITUATION CONCERNING THE ORIGIN OF THE A(1100), K*(1320), AND B(1220) RESONANCES. Curelaru, Irina (Bucharest Inst. of Nuclear Physics). Stud. Cercet. Fiz., 21: 95-110(1969). (In Rumanian).

The $A_1(1100)$ resonance is studied including the Nauenberg-Pais mechanism, the Deck effect, and interference effects. The study of the K*(1320) meson covers the peak position shift and the Deck effect. The B(1220) meson discussion includes the effective mass and Dalitz plots, interference effects, the Deck effect, and the Breit-Wigner formula. (J.F.P.)

39705 πK SCATTERING AMPLITUDE OF THE VENEZIANO TYPE. Tokuda, Naoki (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 41: 853-5(Mar. 1969).

An expression for the πK invariant amplitude of the Veneziano type is constructed under the following conditions: crossing symmetry under $s \leftrightarrow u$; Regge asymptotic behaviors for large s; and

simple poles at points corresponding to resonances on Regge trajectories. The decay width of the K_N meson is predicted, which is in remarkable agreement with the experimental value. (L.B.S.)

39706 CONSTRUCTION AND TESTING OF SUPERCONVERGENT SUM RULES FOR A LINEAR COMBINATION OF PRODUCTS OF AMPLITUDES. Sharma, M. C.; Seth, V. P.; Agarwal, B. K. (Allahabad Univ., India). Progr. Theor. Phys. (Kyoto), 41: 852-3(Mar. 1969).

Super convergent sum rules for a linear combination of amplitudes for $\pi\pi$, πK, $\pi\Xi$ and $K\Xi$, and for $\pi\pi$, πK, $\pi\Lambda$, and $k\Lambda$ elastic scatterings are constructed and tested. Two assumptions usually made in such calculations are explored: (i) the asymptotic behavior of the scattering amplitude is given by the Regge t-channel trajectories, and (ii) the superconvergence relations implied by (i) can well be approximated by taking contributions from the low lying intermediate states. The results are consistent with those obtained from other calculations. (L.B.S.)

39707 ALGEBRAIC REALIZATION OF CHIRAL SYMMETRY AND VENEZIANO MODEL. Fayyazuddin; Riazuddin; Ahmad, Masud (Univ. of Islamabad, Rawalpindi, Pakistan). Phys. Rev. Lett., 23: 103-5(July 14, 1969).

It is shown that the algebraic realization of chiral symmetry in which one assigns the mesons to a representation of the chiral algebra is not consistent with the Veneziano model. (auth)

39708 AN ANALYSIS OF THE $\rho, \omega, \varphi \to 2\pi + \gamma$ DECAYS WITH THE HELP OF CURRENT ALGEBRA. Renard, F. M. (Faculte des Sciences, Montpellier, France). Nuovo Cim., 62A: 475-96 (July 21, 1969).

The decay modes $\rho, \omega, \varphi \to 2\pi + \gamma$ are studied in a gage-invariant way with current algebra, the hard-pion and Ward-identities technique and meson dominance. A comparison with the π, A_1, ρ and σ pology is done and the ω, φ, H, f_0, A_2 terms for the ρ decays and the ρ, B, f_0 terms for the ω, φ decays are added as supplementary "contact terms." The angular distributions, photon spectra and decay rate are discussed in terms of coupling constants (essentially $g_{\omega\rho\pi}$, $g_{\varphi\rho\pi}$, $g_{\rho\pi\gamma}$) and of the σ term parameters (mass and couplings). (auth)

39709 EXACT BETHE-SALPETER AMPLITUDES IN THE STATIC MODEL. Bui-Duy, Q. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim., 62A: 401-10 (July 21, 1969).

The complete B.S. equation and the exact B.S. amplitude are derived in a soluble field model. Abnormal B.S. amplitudes are associated with states primarily composed of field quanta in addition to the two interacting particles. The role of the bound-state energy condition, or consequently the Wick's boundary condition in connection with the existence of abnormal B.S. solutions in the ladder approximation is discussed. (auth)

39710 ANTINUCLEON–NUCLEON INTERACTIONS. Armenteros, R.; French, B. (CERN, Geneva). pp 237-417 of High Energy Physics. Vol. IV. Burhop, E. H. S. (ed.). New York, Academic Press, 1969.

A review is given of the experimental situation regarding antinucleon-nucleon interactions. The total $\bar{p}p$ cross-section measurements are discussed, followed by a discussion of elastic scattering via the optical theorem. Nonannihilation channels involving an antibaryon and baryon or an antibaryon and hyperon in the final state are treated. The results on antiproton-proton annihilations at rest and in flight are presented. The main stress is placed on the production of resonances both in the final states composed of pions only and in those also containing a kaon-antikaon pair. The limited information available on antiproton-neutron annihilations is presented. The results of an experiment on $\bar{p}p$ annihilations into leptons are given. Results on different angular correlations measured in the annihilation center of mass are presented. The final section summarizes and compares with experiment current theoretical ideas about the annihilation process. (L.B.S.)

39711 THE ELEMENTARY PARTICLES WITH STRONG INTERACTIONS. PART 2. THE MESON SYSTEMS. Miller, Donald H. (Univ. of California, Berkeley). pp 111-236 of High Energy Physics. Vol. IV. Burhop, E. H. S. (ed.). New York, Academic Press, 1969.

A historical review is given of the experimental studies which led to the discovery of the meson resonances. Emphasis is placed on the determination of spins and parities. Topics covered include the nonets of pseudoscalar mesons, vector mesons, and spin-two mesons; SU(3) classification of known nonets and the quark model; and evidence for other S = 0 and S = ±1 meson systems. The principal tables of Particle Properties, as compiled by Rosenfeld et al., are appended. (L.B.S.)

39712 SPIN TEST FOR RESONANCES. Celeghini, E. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Nuovo Cim., 62A: 555-60(July 21, 1969).

A simple method to obtain from the decay angles information on the spin of a resonance is illustrated. The utility of the system is in its generality: indeed it can be applied also to no sequential many-body decays where there are no other possibilities. (auth)

39713 GIANT QUARK MODEL. Horn, D. (Tel-Aviv Univ.). Nuovo Cim., 62A: 581-4(July 21, 1969).

A generalized quark model that is based on a tower of quarks with all possible spins and parities is suggested. It can accommodate two 2^{2+} resonances at about the same energy and still continue to have some important characteristics of the usual quark model. (auth)

39714 A RELATIVISTIC FORMULATION OF THE QUARK MODEL FOR MESONS. Smith, C. H. Llewellyn (CERN, Geneva). Ann. Phys. (N. Y.), 53: 521-58(July 1969).

Mesons are treated as bound states in quark-antiquark scattering using the Bethe–Salpeter equation (this does not necessarily imply that the properties of mesons are dominated by the $Q\bar{Q}$ state). It is shown that the existence of very tightly bound states with a nonrelativistic spinor structure (such as are considered in the usual nonrelativistic quark model) requires a Dirac scalar potential (or sum of irreducible graphs) as well as small internal three momentum ($q^2 \ll M_\xi^2$). The assumption that the pseudoscalar mesons have a particular simple relativistic spinor structure leads naturally to the correct value of $\Gamma(\pi \to \mu\nu)/\Gamma(K \to \mu\nu)$ (in contrast to the usual model) and gives the prediction $\gamma_\rho^2 : \gamma_\phi^2 : \gamma_\omega^2 = M_\rho^2 : (3M_\phi^2/\cos^2\theta) : (3M_\omega^2/\sin^2\theta)$ (where γ_V are the usual $V-\gamma$ coupling constants and θ is the $\omega-\phi$ mixing angle) which is compatible with the data. The assumption that the internal momentum is small and the potential is spin-independent can lead to approximate SU(6) symmetry, as in the usual model, although the spinor structure is relativistic. Using the value of the weak axial vector coupling constant for quarks given by the nonrelativistic quark model for baryons, these assumptions lead to the Kawarabayashi–Suzuki relation $2\gamma_\rho f_\pi = M_\rho$ which agrees with experiment. The states which have L = 1 in the usual model are discussed. The model leads naturally to quadratic mass formulas for mesons. The processes $\pi^0 \to \gamma\gamma$ and $\eta^0 \to \gamma\gamma$ are discussed using the relativistic formalism. (auth)

39715 DETERMINATION OF COUPLING CONSTANTS FROM SUPERCONVERGENCE SUM RULES IN VECTOR MESON: VECTOR MESON SCATTERING. Zovko, N.; Andric, I. (Inst. Rudjer Boskovic, Zagreb). Z. Phys., 226: 34-48(1969).

Dynamical relations between masses and coupling constants were studied using the superconvergent sum rule technique in vector meson–vector meson scattering. Unessential complications due to the spin were removed by defining a set of 25 KSF invariant amplitudes. Commonly accepted analyticity properties and asymptotics estimated arguing along the line of unitarity then lead to superconvergent sum rules for three amplitudes. Their saturation by one-intermediate-particle contributions in the process $\omega p \to \omega p$, $\omega B \to \omega B$ and $\omega A_1 \to \omega A_1$ results in a system of nine coupled equations which were approximately solved for coupling constants and a $p-\omega-B-A_1$ mass sum rule. (auth)

39716 DIPOLE A_2 MESON AND THE HIGH-ENERGY REACTION $\pi^+p \to \eta N_3^*$. Antoniou, N. G. (Univ., Tuebingen, Ger.). Z. Phys., 226: 81-5(1969).

On the basis of a dipole model for the A_2 meson, the angular distribution of the high-energy reaction $\pi^+p \to \eta N_3^*$ is described. The results are qualitatively compared with the existing experimental data and with the predictions of the usual Regge pole model. (auth)

39717 RELATIVISTIC QUARK MODELS AND THE CURRENT ALGEBRA. Hill, Roger Calvert. Pasadena, Calif., California Inst. of Tech., 1969. 123p.

Thesis.

The object of this study is to find representations of the albegra of SU(3) vector and axial-vector charge densities at infinite momentum (the "current algebra") to describe the mesons, idealizing the real continua of multiparticle states as a series of discrete resonances of zero width. Such representations would describe the masses and quantum numbers of the mesons, the shapes of their Regge trajectories, their electromagnetic and weak form factors, and (approximately, through the PCAC hypothesis) pion emission or absorption amplitudes. It is assumed that the mesons have internal degrees of freedom equivalent to being made of two quarks (one an antiquark), and models are sought in which the mass is SU(3)-independent and the current is a sum of contributions from the individual quarks. Requiring that the current algebra, as well as conditions of relativistic invariance, be satisfied turns out to be very restrictive, and, in fact, no model was found which satisfies all requirements and gives a reasonable mass spectrum. It is shown that using more general mass and current operators but keeping the same internal degrees of freedom will not make the

problem any more solvable. In particular, in order for any two-quark solution to exist it must be possible to solve the "factorized SU (2) problem," in which the currents are isospin currents and are carried by only one of the component quarks (as in the K meson and its excited states). In the free-quark model the currents at infinite momentum are found using a manifestly covariant formalism and are shown to satisfy the current algebra, but the mass spectrum is unrealistic. Then a pair of quarks is considered bound by a potential, finding the current as a power series in 1/m where m is the quark mass. Here it is found impossible to satisfy the algebra and relativistic invariance with the type of potential tried, because the current contributions from the two quarks do not commute with each other to order $1/m^3$. However, it may be possible to solve the factorized SU(2) problem with this model. The factorized problem can be solved exactly in the case where all mesons have the same mass, using a covariant formulation in terms of an internal Lorentz group. For a more realistic, non-degenerate mass there is difficulty in covariantly solving even the factorized problem; one model is described which almost works but appears to require particles of space-like four-momentum, which seem unphysical. Although the search for a completely satisfactory model was unsuccessful, the techniques used here might eventually reveal a working model. There is also a possibility of satisfying a weaker form of the current algebra with existing models. (Diss. Abstr.)

39718 PION–PION SCATTERING LENGTHS FROM VENEZIANO FORMULA AND $\eta \rightarrow 3\pi$, $K \rightarrow 3\pi$ DECAYS. Hertel, P. (Univ., Heidelberg). Z. Phys., 226: 7-12(1969).

The $\eta \rightarrow 3\pi$ decay amplitude is factorized into (a) the transition matrix element from η to π^0 and (b) Lovelace's expression of the Veneziano type for the pion–pion scattering amplitude. (a) is related with the electromagnetic mass splitting between K^+ and K^0. The absolute value of (b) is then obtained by fitting the η decay width. The pion–pion scattering lengths from (b) are reasonable. Since the analogous treatment of $K \rightarrow 3\pi$ decay together with a soft-pion determination of the $K \rightarrow \pi$ transition matrix element yield very small scattering lengths it is suggested that the $K \rightarrow 2\pi$ transition matrix element depends strongly on the pion masses. (auth)

39719 CURRENT ALGEBRA AND RENORMALIZABLE FIELD THEORIES. Stichel, P. (Univ., Hamburg. Deutsches Elektronen-Synchrotron, Hamburg). Ergeb. Exakten Naturwiss., 50: 110-19(1969).

Renormalizable field theories are discussed describing the interaction of mesons (π) and mesons (σ). Equal-time commutators between axial charges in second order perturbation theory and results on equal-time commutation relations of currents in first order perturbation theory are presented. Ambiguous quantities such as time-ordered products of currents are not considered, and no cut-off is introduced. By calculating the commutators of renormalized currents directly by means of renormalized field operators in perturbation theory unambiguous results are obtained in all cases where the equal-time limit exists. From the results it is concluded that at present the only type of renormalizable interaction for spin-zero field which supports the Gell-Mann SU(2) × SU(2) current algebra hypothesis (for that part which is antisymmetric in the internal quantum numbers) is the Gell-Mann–Levy interaction. (J.F.P.)

39720 NONORTHOGONAL QUASISTATIONARY STATES. Baryshevskii, V. G.; Lyuboshits, V. L.; Podgoretskii, M. I. (Joint Inst. of Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 57: 157-64(July 1969). (In Russian).

Nonorthogonality of unstable states with common decay channels is considered. The mechanism of formation of nonorthogonal unstable states during mixing of orthogonal levels is analyzed within the framework of the two-level problem. Variation of the total number of systems (particles) with time cannot be described, in the case of nonorthogonality of the quasistationary levels, by a sum of exponents, and the energy spectrum of the decay products cannot be reduced to the sum of Breit–Wigner terms. In the particular case of intersection of two nonorthogonal levels decay law obtains which corresponds to the presence of a second order pole in the scattering matrix. (auth)

39721 SU_3 AND SUPERCONVERGENCE IN ANNIHILATION PROCESSES. Bartl, A. (Univ., Tuebingen, Ger.); Urban, P.; Widder, F. Acta Phys. Austr., 28: 19-29(1968). (In German).

The superconvergence relations for the process $\bar{B} + B \rightarrow P + V$ were investigated. Under assumption of SU_3 symmetries on the vertices, the P, V, T, B, and B* multiplets were saturated. A mass formula which connects m_V, m_P, m, and m* and relations between pure meson and baryon-meson coupling constants was obtained. (tr-auth)

Strong (Baryon No. = 1)

Refer also to abstracts 39691, 39706, 39711, and 39820.

39722 (COO-264-498) FORWARD DISPERSION RELATIONS AND MICROCAUSALITY. Oehme, Reinhard (Chicago Univ., Ill.). Apr. 1969. Contract AT(11-1)-264. 44p. (EFI-69-49). Dep. CFSTI.

A brief review is given of the structure of forward dispersion relations and of their derivation on the basis of microcausality, spectral conditions, and other basic notions of relativistic field theory. After a short discussion of the global aspects of local commutativity, the effects of possible violations of microcausality are studied. Modified dispersion formulas are derived under the assumption of exponentially decreasing bounds for the matrix elements of commutators in space-like directions. Simple mathematical models are considered in order to study qualitatively the implications of possible acausal singularities. (auth)

39723 (NP-tr-1826) NEW DATA ON HIGH-ENERGY REACTIONS. Lecture at the Physics School, Erevan, October 1966. Ter-Martirosyan, K. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from report NP-16952. 53p. Dep. CFSTI (U. S. Sales Only).

Handwritten MS Copy.

An abstract of this paper appeared previously in NSA with abstract number 21: 40218.

39724 REGGE POLE MODEL OF STRANGE VECTOR AND TENSOR MESON EXCHANGE PROCESSES. Koike, Kazuo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 442-52(Feb. 1969).

Under the hypothesis of the exchange degeneracy, strange vector and tensor meson exchange processes are investigated in the framework of Regge pole model. In particular, sense-nonsense singularities are discussed in connection with the dip mechanism and the polarization. The possibility of the exponential type residue is also discussed. Detailed comparison with experimental data is made for $\pi^+ p \rightarrow K^+ \Sigma^+$ at 3.23 GeV/c. The differential cross section can be explained fairly well, while there seems to be difficulties in accounting for both polarization and differential cross section. The possibility of removing these difficulties without abandonment of exchange degeneracy is discussed. (auth)

39725 A TEST OF REGGE POLE MODEL. Iwao, Syurei (Kanazawa Univ., Japan). Progr. Theor. Phys. (Kyoto), 41: 562-3(Feb. 1969).

The details of a proposal for testing experimentally the idea of single Regge poles dominance in elastic and quasi-elastic meson-nucleon scattering are summarized. (L.B.S.)

39726 PION EXCHANGE, DUALITY, AND THE FORWARD STRUCTURE OF SCATTERING AMPLITUDES. Avni, Yoram; Harari, Haim (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Lett., 23: 262-5(Aug. 4, 1969).

Forward dips and peaks in π-exchange differential cross sections are analyzed from the t- and s-channel points of view. Simple criteria for the presence of forward structures are given. They lead, among other things, to the prediction that $d\sigma(\pi^- p \rightarrow \rho_{tr}{}^0 n)/dt$, where "tr" denotes transverse polarization, does not have a forward peak with a width of m_ρ^2, contrary to expectations based on vector dominance. (auth)

39727 MASS DEPENDENCE OF THE SMALL-ANGLE DIFFERENTIAL CROSS-SECTION IN THE MULTI-REGGE MODEL. Caneschi, L. (Univ. of California, Santa Barbara). Nuovo Cim., Lett., 2: 122-3(Aug. 1, 1969).

If (as in a previous study of $\pi^+ + p$ and $K^- + p$ inelastic interactions at 8 and 10 GeV/c) the final particles are grouped into two states a and b, one of which, a, consists of a single particle or of a well-defined resonance, then in analogy to two-body processes one can define a momentum transfer t and study the differential cross section $d\sigma/dt$ at a fixed mass squared s_b of the system b. It is pointed out that in the multi-Regge model the smooth decrease of A with s_b is quite natural. It is a consequence of the same mechanism that gives rise to the shrinkage of the forward peak with increasing energy in two-body reactions. It is shown that a very simple version of the multi-Regge model already represents quantitatively the trend of the experimental data. (J.F.P.)

39728 ZEROS IN THE DROPLET MODEL. Lo, S. Y. (Rutherford High Energy Lab., Chilton, Eng.). Nuovo Cim., Lett., 2: 124-6(Aug. 1, 1969).

Expressions for the scattering amplitudes a_0 and a_1 in energy-momentum space in the droplet model are given. It is pointed out

that, while it was previously found that a_0 has zeros, a_1 should have zeros as well. This is applied to $\pi^- + p$ and $\pi^+ + p$ interactions. (J.F.P.)

39729 PARITY CONSTRAINTS AND FACTORIZATION IN THE VENEZIANO MODEL. Costa, G.; Savoy, C. A.; Villani, A. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim., Lett., 2: 137-42(Aug. 1, 1969).

The problem, in the extension of the Veneziano model to processes involving more than one particle with spin, of the parity degeneracy of the Regge trajectories is investigated for processes of the type $\pi(p_1) + X(q,\epsilon_1) \rightarrow \pi(p_2) + X(q,\epsilon_2)$, where X is a vector using a more realistic model in which trajectories of both normalities are present. Also the problem of factorization which relates these processes to $\pi + x \rightarrow \pi + x(X)$, where x is a pseudoscalar meson is examined. (J.F.P.)

39730 REGGE POLE MODELS IN πN AND KN SCATTERING WITH CHARGE EXCHANGE AT HIGH ENERGIES. Derem, A.; Smadja, G. (CEN, Saclay, France). Nuovo Cim., 62A: 681-712 (Aug. 1, 1969). (In French).

The Regge model involving exchange of the ρ and A_2 mesons, originally proposed by Phillips and Rarita, is used at high energy in order to interpret the charge-exchange reactions $\pi^- + p \rightarrow \pi^0 + n$, $\pi^- + p \rightarrow \eta^0 + n$ and $K^- + p \rightarrow \bar{K}^0 + n$. Exact kinematics are introduced for the case of four unequal masses. Solutions for the parameters of the model are presented for $|t| < 1$ (GeV/c)^2 and $|t| < 2$ (GeV/c)^2. At $t = 0$, the parameters are in good agreement with the sum rule proposed by Igi and Matsuda. Predictions at high energy are given for the differential cross sections and polarizations of the two reactions $K^- + p \rightarrow \bar{K}^0 + n$ and $K^+ + n \rightarrow K^0 + p$. In order to interpret the nonzero polarization of the recoil nucleon in the reaction $\pi^- + p \rightarrow \pi^0 + n$, the hypothetical ρ′-meson is introduced in the formulation of Sertorio and Toller, which it is found does not significantly modify the residue functions previously obtained. However, the correction introduced by the ρ′ does not resolve the discrepancy with an experimental result at 3 GeV/c for the reaction $K^+ + n \rightarrow K^0 + p$. It is probable that the Regge model is not yet applicable at such a low energy. (auth)

39731 LARGE ANGLE DIFFRACTION SCATTERING. Fukuda, Reijiro; Miyazawa, Hironari (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 41: 1247-50(May 1969).

The amplitude for diffraction scattering due to an absorbing hard core is calculated and a formula valid even for a large scattering angle is obtained. The forward and backward diffraction scattering amplitudes are correlated and a comparison with experiment is made for πp scattering. (auth)

39732 CORRECTION TO ONE-PARTICLE-EXCHANGE CONTRIBUTION AND TWO-BODY REACTION AT HIGH ENERGY. Hama, Mitsuru; Iwaki, Atsuko; Sokawa, Tohru; Suzuki, Haruo (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 41: 1238-46(May 1969).

Two-body reactions at high energies are investigated by using a model in which some of assumptions used in the absorption model are removed. Our model can avoid the difficulty of energy dependence in the absorption model and moreover includes contributions from inelastic intermediate states. The energy dependence of the cross section for a two-body reaction comes essentially from the difference of the related two elastic scatterings. Qualitative discussions are given for general processes and the quantitative estimate of the cross section for $\pi^- p \rightarrow K^0 \Lambda$ is presented. (auth)

39733 EFFECT OF PION–NUCLEON FINAL STATE INTERACTION IN BACKWARD PION PHOTOPRODUCTION FROM DEUTERIUM IN 1 GeV REGION. Sumi, Yoshio (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 41: 1227-37(May 1969).

The effect of pion-nucleon final state interaction in the backward pion photoproduction from deuterium is calculated by using several assumptions such as the closure approximation, the use of static model, etc., for the incident photon energy $E_\gamma \sim 1$ GeV, where the final pion-spectator system is just in the 3-3 resonance. It is shown that the effect is negligible within the presently available experimental resolution. Correction to the impulse approximation calculation is estimated to be of the order of a few percent almost indopendently of the detail of photoproduction amplitudes in the rather wide range of E_γ. (auth)

39734 SUPERCONVERGENCE SUMRULES FOR ρΣ AND ρΞ ELASTIC SCATTERING. Seth, V. P.; Agarwal, B. K. (Allahabad Univ., India). Progr. Theor. Phys. (Kyoto), 41: 847-8(Mar. 1969).

Sum rules involving the mixing parameter for tensor coupling and the coupling constant related to the vertex ρΣY*, or ρΞΞ* are derived. (L.B.S.)

39735 POSSIBLE EXISTENCE OF AN ACAUSAL DISTANCE IN HIGH ENERGY PHYSICS. Sekine, Matsuo (Tokyo Inst. of Tech.). Progr. Theor. Phys. (Kyoto), 41: 843-5(Mar. 1969).

The ratio of the real to the imaginary parts of the pion-nucleon forward elastic scattering amplitude was calculated previously using an acausal dispersion relation. The real part of the forward dispersion relation is re-examined in order to test precisely the validity of the dispersion relations. The predictions from the acausal dispersion relations, including an acausal distance $a_0 = 0.85 \times 10^{-13}$ cm, are in rather good agreement with experiment. (L.B.S.)

39736 COMPOSITE MODEL AND HIGH ENERGY QUASI ELASTIC SCATTERING. Hasebe, Katsuya (Aichi Univ., Toyohashi, Japan); Kanada, Hiroyuki; Sakai, Kenji; Yasuno, Masaru. Progr. Theor. Phys. (Kyoto), 41: 838-40(Mar. 1969).

The energy dependence of high-energy $\pi^- p \rightarrow \pi^0 n$ forward scattering is discussed from the viewpoint of the composite model, using the quark model for simplicity. It is shown that the energy dependence is closely related with the rearranging mechanism of quarks. (L.B.S.)

39737 REGGE POLE MODEL OF THE REACTION $\pi N \rightarrow \omega N$. Nobuyama, Masayuki (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 730-8(Mar. 1969).

The angular distribution and decay density matrix of ω in the forward direction of the high-energy reaction $\pi N \rightarrow \omega N$ are investigated in terms of ρ + B Regge pole model. B exchange plays a significant role in order to reconcile theory with experiment. The present data can be explained without conspiracy. Factorization of ρ residues is argued by studying the density matrix element ρ_{1-1}. (auth)

39738 PION–NUCLEON LOW ENERGY PARAMETERS FROM DISPERSION RELATIONS FOR INVERSE FORWARD AMPLITUDE. Miyamura, Osamu; Takagi, Fujio (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 41: 723-9(Mar. 1969).

The dispersion relations for the inverse of the crossing-even πN forward amplitude $M^{(+)}(\nu)$ are derived and used together with ordinary ones to determine the πN low energy parameters provided that $g^2/4\pi = 14.6$ and $a_1 + 2a_3 < 0$. The results are $a_1 - a_3 = 0.296 \pm 0.0066\mu^{-1}$, $a_1 + 2a_3 = -0.035 \pm 0.017\mu^{-1}$, $g^2/4\pi m - M^{(+)}(0) = 0.819 \pm 0.046$ BeV^{-1}, $\lambda = 0.305 \pm 0.004\mu$ and $i \lim(\nu - i\lambda)/M^{(+)}(\nu) = (24.10 \pm 0.86) \times 10^{-3}$ BeV^2, where $M^{(+)}(\pm i\lambda) = 0$, ν the lab. energy of the incident pion, and μ the mass of the pion. Combining our results with Sato's sum rule for $\sigma_{\pi N}(\infty)$, $\sigma_{\pi \bar{N}}(\infty) = 18.8 \pm 1.8$ mb is obtained which is in excellent agreement with a previous result obtained from Igi's sum rule for the P and P′ Regge parameters. (auth)

39739 THE ELEMENTARY PARTICLES WITH STRONG INTERACTIONS. PART 1. THE BARYON SYSTEMS. Miller, Donald H. (Univ. of California, Berkeley). pp 1-110 of High Energy Physics. Vol. IV. Burhop, E. H. S. (ed.). New York, Academic Press, 1969.

Those aspects of phenomenological theory which have proved most useful in clarifying the properties of resonant states are briefly summarized. A detailed discussion is given of the experiments which led to particularly important discoveries, or which illustrated the application of particular techniques of analysis. The topics covered include two-body final states; strong production and decay processes; and S = 0, −1, −2 baryon systems. Possible resonances in other systems are also discussed. (L.B.S.)

39740 EQUAL-TIME COMMUTATORS AND LOW-ENERGY PION PHYSICS. de Alfaro, V. (Univ., Bari, Italy. Istituto Nazionale di Fisica Nucleare, Bari, Italy); Fubini, S.; Furlan, G.; Rossetti, C. Contract AT(30-1)-2098. Nuovo Cim., 62A: 497-513(July 21, 1969).

A general formalism is discussed where physical-pion amplitudes at low energy are expressed in terms of equal-time commutators of current algebra and field algebra plus a dispersionlike sum over intermediate states. This result generalizes a previous treatment valid for pions at rest. (auth)

39741 ELASTIC PION–NUCLEON SCATTERING. Horvath, Zalan (Univ., Miskolc, Hungary); Pocsik, Gyoergy. Magy. Fiz. Foly., 17: 127-64(1969). (In Hungarian).

The dispersion relations of elastic scattering within the framework of the π-N interaction up to the 700-MeV region are analyzed. The study revealed that although the πN interaction has been known for a long time, the problems involved are far from being completely clarified. At the low energy range, Hamilton and coworkers made the most generally accepted analysis; the bootstrap calculations did not yield satisfactory results. The phenomenological approach was examined, describing the πN dispersion system and the amplitudes involved and presenting the calculation of low-energy partial waves. This is followed by the presentation of the dispersion relations of partial waves. Starting from the s-wave data, the $\pi\pi \rightarrow N\bar{N}$ channel and the existence of the σ meson are discussed. (Review article, 7 references). (TTT)

39742 GENERALIZED ISOSPIN MATRICES AND PROJECTION OPERATORS FOR THE REACTIONS $N_I + \pi \rightarrow N_{I'} + \pi$ AND $N_I + \bar{N}_{I'} \rightarrow \pi + \pi$. Carruthers, P. (Cornell Univ., Ithaca, N. Y.); Nieto, Michael Martin. Ann. Phys. (N. Y.), 51: 359-77(Feb. 1, 1969).

Generalized isospin variables of the other particles are treated symmetrically. A phase-consistent set of projection operators and crossing matrices is constructed for the s, t, and u channels of the reaction $N_I + \pi \rightarrow N_{I'} + \pi$, where N_I, $N_{I'}$ are particles of any isospin I, I'. Applications of these results are discussed briefly. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 39691, 39711, and 39855.

39743 (ITF-69-35) ON THE INFLUENCE OF THE UNCORRELATED $\pi\pi$-INTERACTION ON NN-SCATTERING. Lend'el, V. I.; Tovtin, E. V.; Ernst, B. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 11p. (In Russian). (CONF-690417-8). Dep.

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

The results of the calculations of NN-partial waves with isotopic spin value I = 1 in one-boson-exchange model with the inclusion of uncorrelated $\pi\pi$-interaction according to [I] are given. It turns out that the pure OBE model gives a somewhat better agreement of theory with experiment. Nevertheless the final solution to the problem of importance of the uncorrelated $\pi\pi$-interaction in question may be reached only after simultaneous consideration of the other strong interactions. (auth)

39744 (KFKI-10/1969) CHARGE-STATE OSCILLATIONS IN NEUTRON–PROTON SCATTERING. Hrehuss, Gy.; Czibok, T. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Mar. 27, 1969. 39p. Dep.

Periodic state-flipping phenomena analogous to those occurring at electromagnetic excitations were found for neutron-proton scattering. The periodic charge-state flipping manifests itself as an oscillation in the energy dependence of both the total cross section and the differential cross section at forward proton angles. The flipping frequency measured is in good agreement with that estimated theoretically making use of a simple model for charge-exchange processes. (auth)

39745 (LNF-69/23) MINIMAL SOLUTIONS TO THE CONSPIRACY PROBLEM AND CLASSIFICATION OF REGGE POLE FAMILIES. [PART] II. Note No. 440. Di Vecchia, P.; Drago, F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy) Laboratori Nazionali di Frascati). Apr. 10, 1969. 26p. Dep.

A nongroup-theoretical approach to the conspiracy problem, based on analyticity, crossing symmetry and factorization, is presented. The solutions to all the physically interesting cases are given. A classification of Regge pole families is deduced. (auth)

39746 (LNF-69/30) POMERANCHON EXCHANGE AND p-p ELASTIC SCATTERING. Note No. 445. Greco, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). May 7, 1969. 9p. Dep.

A representation for the Pomeranchon exchange and the multiple scattering corrections is suggested, which contains crossing symmetry, asymptotic Regge behavior, and obeys the duality requirement of a nonresonating background. A very good description of the proton-proton elastic scattering is obtained in the diffraction, intermediate- and large-angle regions. (auth)

39747 ONE-BOSON-EXCHANGE MODES AND TWO- AND THREE-PION EXCHANGE IN NUCLEON–NUCLEON SCATTERING. II. Furuichi, Susumu (Rikkyo Univ., Tokyo); Suemitsu, Hiroshi; Watari, Wataro; Yonezawa, Minoru. Progr. Theor. Phys. (Kyoto), 41: 461-72(Feb. 1969).

A detailed comparison is made between the theoretical two-pion-exchange amplitudes and the experimental values for the left-hand-cut contribution in nucleon-nucleon scattering for both the T = 1 and T = 0 nucleon-nucleon states in order to confirm the conclusions of the previous analysis where only the T = 1 states are analyzed. The conclusion obtained in the previous analysis was that the uncorrelated two-pion-exchange amplitudes can explain the T = 1 nucleon-nucleon scattering together with the effects of the one-pion, one-ρ-meson and one-ω-meson exchanges and without effects of scalar mesons, if the squared momentum of the exchanged pions is cut off at $t_{max} \sim 9\mu^2$. It is shown in this paper that this conclusion is also valid for the T = 0 nucleon-nucleon states. Some positive evidence is found for the fact that the two-pion-continuum contributions are favorable over the discrete (scalar boson) pole-type contributions. Implication of the small cutoff momentum, $t_{max} \sim 9\mu^2$, is discussed.

39748 LARGE ANGLE SCATTERING AND LINEAR REGGE TRAJECTORY. Yoshida, Toshihiro (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 453-60(Feb. 1969).

The Regge pole model is applied to large angle scattering. It is shown that the contribution to the fixed-angle cross section from the Regge pole with linear trajectory decreases exponentially with P_{CM}^4. The behavior of the residue function is discussed in view of the composite model and is assumed not to have strong t-dependence in large −t region. Then it is found that the contribution of the pole with the trajectory, $\alpha(t) = -0.8 + 0.14\ t$, is sufficient to explain both the s- and t-dependence of large angle cross section in p-p elastic scattering; the energy dependence of the cross section at $\theta_{CM} = 90°$ is predicted to be nearly exp $[-P_{CM}]$ in the high energy limit. (auth)

39749 REPULSIVE CORE AND THE NONSTATIC EFFECTS OF NUCLEAR FORCES IN MOMENTUM SPACE. Wada, Masanobu (Nihon Univ., Funabashi, Japan). Progr. Theor. Phys. (Kyoto), 41: 105-30(Jan. 1969).

Nucleon–nucleon scattering due to the exchange of π, ω, ρ, and an isoscalar scalar meson is calculated for spin singlet states in momentum space. The problem of whether or not the ω-meson exchange can be the origin of the repulsive core is considered by treating the nonstatic effects of heavy mesons as accurately as possible. The ω-nucleon coupling constant obtained in the $^1S_0$ state by momentum-space calculations can be taken smaller than that obtained from the static coordinate-space potential, but is still too large to reconcile with small values inferred from the higher partial wave fit. In the framework of the one-boson-exchange model, the non-static effects are attractive and cannot produce the repulsive effects in the $^1S_0$ state. Comparison with the results obtained from the velocity-dependent potential shows that such attractive nonstatic effects can be simulated by the effect of a p^2-dependent term. (auth)

39750 ONE-BOSON-EXCHANGE MODES AND TWO- AND THREE-PION EXCHANGE IN NUCLEON–NUCLEON INTERACTION. I. Furuichi, Susumu (Rikkyo Univ., Tokyo); Ueda, Tamotsu; Watari, Wataro; Yonezawa, Minoru. Progr. Theor. Phys. (Kyoto), 41: 131-44(Jan. 1969).

The experimental values for the left-hand-cut contributions in T = 1 nucleon-nucleon scattering in the elastic region are analyzed by the one-, two-, and three-pion-exchange contributions. As the two-pion-exchange amplitudes, the ones calculated by Furuichi and Watari from the CGLN amplitudes are used for $N + N \rightarrow \pi + \pi$. The three-pion-exchange amplitudes are treated phenomenologically by bosonizing them. The results show that nucleon–nucleon scattering can be explained by the uncorrelated two-pion-exchange contributions without scalar meson if the small cutoff for the squared momentum of the exchanged pions is taken as $t_{max} \sim 9\ \mu^2$. It is also found that the three-pion-exchange modes would not contribute if $g_S^2/4\pi$ is taken as 14.4, the usually assumed value, or larger and that the effective coupling constants of the three-pion modes are $g_{AV}^2/4\pi < 10$ and $g_{PS}^2/4\pi < 20$, assuming the resonance masses as the effective masses for the three-pion modes. (auth)

39751 $^1S_0$ PHASE SHIFT OF THE NUCLEON–NUCLEON SCATTERING BY THE NAMBU–SALPETER–BETHE EQUATION. Murota, Toshiyuki (Osaka City Univ.); Noda, Matu-Tarow; Tanaka, Fujio. Progr. Theor. Phys. (Kyoto), 41: 1251-9(May 1969).

The Nambu-Salpeter-Bethe equation in the pion-ladder approximation for the $^1S_0$ state of the nucleon-nucleon scattering is solved numerically. In this calculation, the contribution from the negative energy amplitudes in the elastic energy region is neglected. The results obtained here agree qualitatively with, but are quantitatively different from the corresponding 3-dimensional calculation. This difference is caused by our full counting of the retardation effect which is treated incompletely in the 3-dimensional calculation. (auth)

39752 ON THE CONTRIBUTIONS FROM HEAVY PSEUDOSCALAR MESONS TO THE NUCLEON–NUCLEON INTERACTION. Furuichi, Susumu (Rikkyo Univ., Tokyo); Watari, Wataro; Yonezawa, Minoru. Progr. Theor. Phys. (Kyoto), 41: 850-2 (Mar. 1969).

The contributions of heavy pseudoscalar mesons to nucleon-nucleon scattering are reanalyzed considering both the T = 0 and 1 states. The pseudoscalar mesons concerned with are the η and the I = 1, L = 0 part of the three-pion exchange. Information on the coupling constants is obtained. (L.B.S.)

39753 ANALYSIS OF THE DECAY RATES OF Λ-H^3 AND Λ-H^4. Bhamathi, G.; Prema, K. (Univ. of Madras). Nuovo Cim., 62A: 661-70(July 21, 1969).

The decay rates and two-body decay mode branching ratios of

the hypernuclei $_{\Lambda}H^3$ and $_{\Lambda}H^4$ are calculated using separable-potential model wave functions. (auth)

39754 CASCADE CALCULATION FOR THE INTERACTION OF 7.5-GeV π^- MESONS WITH THE HEAVY NUCLEI OF NUCLEAR EMULSIONS. Klebuhn, J. (Institut fuer Hochenergiephysik, Zeuthen, Ger.). Monatsber. Deut. Akad. Wiss. Berlin, 11: 95-105(1969). (In German).

The interaction of 7.5 GeV π^- mesons with a packet of NIKFI-R nuclear emulsions was analyzed by a cascade calculation. The momentum distribution of the mesons in the laboratory system was determined. For the calculation of the AgBr nuclei of the emulsion were considered as a Fermi gas which fills a spherical volume with constant density. The comparison of the distribution of the mesons and protons with the experimental distributions gave agreement with the exception of the angular distribution of the protons. The deviations could not be attributed to statistical variations. There is also considerable difference between the mean number of π mesons and protons in experiment and calculation. The deviations can be explained if it is assumed that the pion-nucleon resonances interact with nucleons without emission of π mesons. (J.S.R.)

39755 $\Lambda-\Sigma$ CONVERSION AND ΛNN ISOPIN ZERO BOUND STATES. Toepfer, Alan James. Los Angeles, Univ. of Southern California, 1968. 69p.

Thesis.

The bound states of Λ-hyperons and light nuclei have provided an important tool in the study of the strong interactions. The lightest of the hypernuclei is the hypertriton $_{\Lambda}H^3$, which consists of a Λ-hyperon bound to a deuteron with a binding energy of about 0.06 MeV. The hypertriton has isospin zero and a total spin of one-half. The Λ-nucleon (ΛN) interaction differs from the NN interaction in that one-pion exchange is forbidden due to isospin conservation. One-pion exchange can occur, however, through the virtual process $\Lambda N \leftrightarrow \Sigma N$, where the ΣN threshold is 78 MeV above the ΛN elastic scattering threshold. The explicit consideration of the Σ-channel leads to a ΛN potential which is energy-dependent and the possibility of a three-body scattering process in hypernuclei. The shift in binding energy of the ΛNN isospin zero, spin $\frac{1}{2}$ and $\frac{3}{2}$ systems due to virtual $\Lambda N \leftrightarrow \Sigma N$ transitions was calculated. The Faddeev multiparticle scattering formalism along with nonlocal, separable, spin-dependent, charge symmetric, S-wave potentials was used, and a coupled set of one-dimensional, linear integral equations for the Λ-deuteron, S-wave, elastic scattering amplitudes was derived. The two-body ΛN interactions were fit to the ΛN singlet and triplet shape-independent parameters, and the ΣN interactions were related to the ΛN potentials using two different symmetry models. All calculations in the spin $\frac{1}{2}$ state were made using purely attractive potentials, while for some cases in the spin $\frac{3}{2}$ state, a repulsive core was included in the ΛN potential. It was determined that the effect of a finite coupling to the Σ-channel was to reduce the binding energy of the ΛNN system in both the doublet and quartet spin states. The shift in binding energy due to three-body processes in which $\Lambda N \rightarrow \Sigma N$ followed by $\Sigma N \rightarrow \Lambda N'$, where $N \neq N'$, was comparable to that arising from purely two-body processes. It was possible to obtain a binding energy in the spin $\frac{1}{2}$ state which was in agreement with the experimental value using purely attractive potentials and the shape-independent parameters from Λ-proton scattering experiments only if a finite coupling to the Σ-channel was included. A possible bound state in the spin $\frac{3}{2}$, Λ-deuteron t-matrix was found to be destroyed by assuming a finite coupling to the Σ-channel. (Diss. Abstr.)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 39780, 39785, and 39846.

39756 SPECTRAL FUNCTION SUM RULES FOR NON-CONSERVED CURRENTS AND O(4) SYMMETRY. Bose, S. K.; Loebbaka, D. S. (Univ. of Notre Dame, Ind.). Progr. Theor. Phys. (Kyoto), 41: 273-4(Jan. 1969).

A different type of spectral function sum rule is considered, namely, one which connects the "spin zero" and "spin one" parts of the partially conserved (axial) vector current propagator. The new sum rule follows from the requirement of definite tensorial behavior of the current propagator at zero four-momentum under the group O(4). (L.B.S.)

39757 HIGH SPIN PROPAGATION OF MASSIVE AND MASSLESS PARTICLES. Hayashi, Kenji (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 41: 214-32(Jan. 1969).

The propagators for different arguments are explicitly given for any spin in terms of SO(N) projection operators (N = 2, 3, and 4). For massive particles of integer spin J, from among GL(4) representations, symmetry and tracelessness of the rank-J tensor fields take D(J/2,J/2) of the Lorentz group, out of which divergence-free conditions choose D(J) of SO(3), the little group of the Poincaré group. The propagators pass to this little-group projection operators, which are then boosted to Minkowski space. Trace-free and divergence-free conditions are lifted off the mass shell, where the propagators turn to projection operators of a particular GL(4) representation, letting loose a set of superfluous spins $(J-1, J-2, \ldots, 0)$ initially excluded by the on-shell subsidiary conditions; these low spins do not propagate but give rise to transitions and cooperate in getting rid of singularity in the scattering amplitudes. This necessarily follows from the present tensor formalism, whence it may be regarded as a dynamical assumption for off-shell spin. For half-integer spin $J + \frac{1}{2}$, we make use of $J + \frac{1}{2}$ projection operators acting on the tensor (rank J)-spinor fields. A transition to massless particles is, except for $J = 0, \frac{1}{2}$, prohibited due to M^2 singularity, which is to be removed by gauge transformations peculiar to massless particles. In the radiation gauge of transversal states, the propagators are constructed by projection operators of SO(2), a compact subgroup of the little group E_2. In the Feynman gauge involving unphysical polarizations, the propagators are given by SO(3,1) projection operators; hence a series of redundant spins $(J-2, J-4, \ldots)$ propagates. The complication of gauges arises from the use of the D(J/2,J/2) fields; the present formalism is not so simple for massless particles as for massive particles. Comparison with propagators derived from Lagrangians is made for several spins: Differences lie in the terms multiplied by the Klein–Gordon operator, hence vanish on the mass shell. A choice of parameters left undetermined by the Lagrangian method fixes, off the mass shell, a particular composition of spin contents $(J-1, J-2, \ldots, 0)$, which can be further changed in view of non-uniqueness of the propagators for identical arguments. (auth)

39758 A LEMMA ON THE STRUCTURE OF LIE ALGEBRAS AND THE PROBLEM OF THE COMBINATION OF RELATIVISTIC AND INTERNAL SYMMETRIES. Berzi, V. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Nuovo Cim., Lett., 2: 156-8(Aug. 1, 1969).

The mathematical aspects of the problem of the combination of relativistic symmetries in elementary particle physics are studied. A series of negative theorems given previously on the possibility of combining relativistic and internal symmetries are analyzed. Also a lemma giving a sufficient condition for a subalgebra of a Lie algebra A to be an ideal of A, which can be immediately applied to most of the situations treated previously, is stated, proven, and applied to the combining problem. (J.F.P.)

39759 NOTE ON THE CG COEFFICIENTS OF SU(3). Majumdar, S. Datta (Indian Inst. of Tech., Kharagpur). Progr. Theor. Phys. (Kyoto), 41: 1382-4(May 1969).

The derivation of a relatively simple expression for the normalized Clebsch–Gordon coefficients of SU(3) is reported. (L.B.S.)

39760 REPRESENTATIONS OF $O_{3,1}$ IN BISPINOR SPACE AND GEOMETRIZED CLIFFORD ALGEBRAS. Ndili, F. N. (Daresbury Nuclear Physics Lab., Lancashire, Eng.). Nuovo Cim., 62A: 615-30(July 21, 1969).

The problem of constructing spinor representations of improper transformations of the pseudo-orthogonal groups is discussed. The specific case of the Lorentz group is reviewed. The results are rederived from spinor theory and the advantages of this method over the conventional approach are pointed out. (auth)

39761 MASS, MOMENTUM, AND THE CONFORMAL GROUP. Rosen, J. (Brown Univ., Providence). Nuovo Cim., 62A: 648-60(July 21, 1969). (NYO-2262-TA-186).

The transformation of mass and momentum under the special conformal transformations of the space-time conformal group is investigated in general and in three special cases. An antiparticle-like phenomenon is pointed out. (auth)

39762 NOTE ON AN "EXTENSION THEOREM" BY A. SANKARANARAYANAN. Berendt, G.; Weimar, E. (Freie Univ., Berlin). Nuovo Cim., Lett., 1: 842-4(June 1, 1969).

It is pointed out that a previous extension theorem for inhomogeneous pseudo-orthogonal Lie algebras is a special case of a rather general relation well-known in literature as the Gell–Mann formula and that therefore most of the results from this extension theorem are simple consequences of this general relation. (J.F.P.)

39763 REALIZATIONS OF A COMPACT, CONNECTED, SEMISIMPLE LIE GROUP. Wess, Julius (Univ., Karlsruhe, Ger.). Ergeb. Exakten Naturwiss., 50: 132-42(1969).

The problem of finding all realizations of a compact connected semi-simple Lie group which can be linearized when restricted

to a continuous subgroup is solved. A method was developed which allows such realizations to be transformed into a standard form. Also relations between linear and nonlinear transformations are treated. (J.F.P.)

39764 SYMMETRIES OF ELEMENTARY PARTICLES. Ruehl, W. (CERN, Geneva). pp 215-28 of Atome, Kerne, Elementarteilchen. Suessmann, Georg; Fiebiger, Nikolaus (eds.). Frankfurt am Main, Umschau Verlag, 1968. (In German).

Elementary particles and symmetries are defined. SU(3) and SU(6) symmetries are then discussed. (J.S.R.)

Applications (Electromagnetic and Weak)

Refer also to abstract 39601.

39765 A PHENOMENOLOGICAL ANGLE FOR SU(3)⁻ SYMMETRY BREAKING. II. NON-LEPTONIC K-MESON AND $\Delta I = \frac{1}{2}$ RULE. Konno, Kimiaki (Kihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 41: 176-81(Jan. 1969).

The breaking of the $\Delta I = \frac{1}{2}$ rule in nonleptonic K-meson decays is studied by introducing an empirical angle. The model leads to several interesting relations for the breaking of the $\Delta I = \frac{1}{2}$ rule. It is found that these relations are in excellent agreement with experiment by using the same value of the angle for the three-body semi-leptonic decays of pseudoscalar mesons in a previous paper. (auth)

39766 AN EXPRESSION FOR RELATIVE STRENGTH OF CHIRAL AND SU(3) BREAKING INTERACTIONS. Acharya, R. (Univ., Bern). Helv. Phys. Acta, 42: 663-6(July 1, 1969).

An explicit expression is derived as a function of π, K, $\varkappa$, K* and K_A masses for the parameter ϵ_8/ϵ_0 which measures the strength of SU(3) breaking interaction relative to chiral symmetry breaking. The departure of the numerical value of this parameter from its SU(2) ⊗ SU(2) symmetric value is determined and the result is compared with the estimate given by Gell-Mann, Oakes and Renner. (auth)

39767 THE PRINCETON–RUTHERFORD DILEMMA. Chela-Flores, J.; Colegrave, R. K. (London Univ.). Nuovo Cim., Lett., 2: 131-4(Aug. 1, 1969).

Previously a systematic study was carried out of the consequences of CPT invariance and unitarity with respect to η_+ and η_{00}, the defining parameters of CP violation in dipion decays of the long-lived kaon. Previous use of the generalized parametrization is refined. The derivation of the equation $|\eta_{00}| \simeq |\eta_+|$ is considered as a first approximation of the $|\eta_{00}|$ parameter. In making this estimate a relation is used which is equivalent to the approximate equation b = 0. Thus a better estimate of $|\eta_{00}|$ would be achieved if instead of twice one only used the vanishing of the b-parameter once. It is shown that this can be done. It is found that within the generalized parametrization well-established data strongly favor a low value for $|\eta_{00}|$. (J.F.P.)

39768 A MODEL OF CP VIOLATION. Nishijima, Kazuhiko (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 41: 739-61(Mar. 1969).

A model of CP violation is proposed. In this model both CP-conserving and -violating nonleptonic decays are attributed to the same primary interaction, and they occur, respectively, in the second and third orders of the primary interaction. This model predicts (1) $3 \times 10^{-3} > |\eta_{00}| > 1 \times 10^{-3}$, and (2) $|D| = |\mu_{e,n}/e| = 2 \times 10^{-22}$ cm for the neutron. (auth)

39769 K_{l3}-DECAY FORM FACTORS AND DYNAMICAL GROUP O(4,2). Arisaka, Nakateru; Toda, Azuma (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 41: 848-50(Mar. 1969).

The form factors of K_{l3} decay are evaluated on the assumption that the framework of O(4,2) is also applicable to transitions between the members of an SU(3) multiplet. (L.B.S.)

39770 ON MAGNETIC MOMENTS OF BARYONS IN SU(6) SYMMETRY SCHEME. Dzhrbashyan, V. A. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 408-19 (1968). (In Russian).

The proton magnetic susceptibility which is connected with the squares of magnetic moment in the unbroken SU(6) symmetry is considered. A disagreement is found between the experimental value and the prediction of SU(6) symmetry for the transition magnetic moment observed earlier for other effects. (auth)

39771 THEORY OF NONLEPTONIC DECAYS. CRITIQUE AND REFORMULATION OF THE NISHIJIMA–SWANK MODEL. Matsuda, Takashi (Tokyo Inst. of Tech.). Progr. Theor. Phys. (Kyoto), 41: 1273-88(May 1969).

The Nishijima–Swank model ($L_{NL} = -f\partial_\lambda K_\lambda^W$) for the Lagrangian of nonleptonic decays is investigated under certain assumptions. The model is found to be a mismatch theory of CP operator among H_{SL}, H_{NL}(P.C.) and H_{NL} (P.V.). $|\Delta I| = \frac{1}{2}$ holds for both CP conserving and CP violating nonleptonic decays. α and f are determined by the soft pion theory. The asymmetry parameters Δ and ϵ in the $K_L \to 2\pi$ problem are calculated and the electric dipole moment of neutron is found to vanish with a few additional assumptions. (auth)

39772 PROPOSALS FOR MEASUREMENT OF CP VIOLATING PARAMETERS IN K^0 DECAYS USING e^+e^- COLLIDING BEAM. Kamae, Tsuneyoshi; Kifune, Tadashi; Tsunemoto, Kenji (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 41: 1267-72 (May 1969).

Experiments are proposed which enable the CP violating quantities, $|\eta_+|^2 - |\eta_{00}|^2$ and $\phi_+ - \phi_{00}$ in $K^0_{2\pi}$ and Im(x) in K^0_{l3}, to be measured directly by making use of the $(K^0\overline{K}^0)$ state of ϕ decay produced in the e^+e^- colliding beam machine. (auth)

39773 $\beta-\gamma$ (CP) CORRELATION MEASUREMENTS IN ^{48}Sc, ^{65}Ni, AND ^{152}Eu. Behrens, H.; Wischhusen, R. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Z. Phys., 226: 86-102(1969). (In German).

The $\beta-\gamma$ circular polarization asymmetry of allowed β-decays was measured for three nuclides. The polarimeter was the at Karlsruhe developed type. The results of the measurements are the following: ^{48}Sc + 0.0553 ± 0.0055, ^{65}Ni + 0.292 ± 0.037, ^{152}Eu + 0.107 ± 0.012. From these values the Fermi- and effective Coulomb matrix elements are determined. Corrections from higher order forbidden matrix elements are discussed. (auth)

39774 K-MESON DECAY AND THE SYMMETRY OF MATTER AND ANTIMATTER. Faissner, Helmut (Technische Hochschule, Aachen). pp 165-91 of Atome, Kerne, Elementarteilchen. Suessmann, Georg; Fiebiger, Nikolaus (eds.). Frankfurt am Main, Umschau Verlag, 1968. (In German).

The strong production and weak decay of mesons is illustrated. Strangeness is defined. The decay of charged K mesons and the mirror symmetry of the world are discussed. The concept of particles and antiparticles is then considered. Short-lived and long-lived neutral K mesons are discussed. The difference between matter and mirrored antimatter is described. (J.S.R.)

39775 BARYON CURRENT SOLVING SU(3) CHARGE-CURRENT ALGEBRA. Kleinert, Hagen (Freie Univ., Berlin). Ergeb. Exakten Naturwiss., 50: 90-146(1969).

The group dynamical prescriptions for constructing conserved currents of baryons of fixed internal quantum numbers are extended as to apply to the whole SU(3) octet of weak and electromagnetic currents. It is shown how for any dynamical group such a current octet can be found which satisfies the charge-current commutation rules at infinite momentum and is not proportional to the particle charges. The SU(3) symmetry described by these currents is broken, such that the masses within every SU(3) multiplet are split and strangeness changing currents are not conserved. Finally, some comments are made on a possible extension of the algebra by an axial-vector octet of currents in order to generate the full chiral SU(3) × SU(3) charge-current algebra. (auth)

Applications (Strong)

39776 (NYO-3399-194) NOTE ON THE GAUGE FIELD CHIRAL LAGRANGIAN. Schechter, J.; Ueda, Y. (Syracuse Univ., N. Y. Dept. of Physics). May 1969. 43p. (SU-1206-194). Dep. CFSTI.

The SU(3) × SU(3) chiral Lagrangian with gauge fields is discussed, including a consideration of SU(3) symmetry breaking. In addition to details of the formulation, applications to π-N scattering lengths, K^+-N scattering lengths and semi-leptonic decays are treated. The S-wave π-N scattering lengths are found to be independent of the vector meson dominance assumption. A possible "improvement" of the calculation by adding the N* particle is also discussed. The K^+-N S-wave scattering lengths can be calculated in good agreement with experiment when all symmetry breaking (including ω-ϕ mixing) is put into the mass terms of the physical particles and it is assumed that the physical ϕ particle decouples from the nucleons. Alternative SU(3) breaking schemes are investigated and for a modified mass-term mixing model the renormalizations to the Cabibbo theory for all semi-leptonic decays can be correlated in terms of one (known) parameter. (auth)

39777 STRONG COUPLING AND SU(3). von der Linden, Frits Jozef Marie. Nijmegen, Netherlands, Univ. of Nijmegen, 1968. 128p.

Thesis.

The generation of baryon spectra in strong coupling models is

studied. The groups SU(2) and SU(3), the hamiltonian, the strong coupling limit, eigenvalues and eigenvectors of H_I, possible representations, the effect of H_0, and the breaking of SU(3) symmetry in the scalar model are considered. It is found that despite the approximations and assumptions made, the static strong coupling models results seem to reflect the situation in nature. It is noted that all states in the models have the same parity, and that if one assumes for the bare baryons a positive intrinsic parity all states have positive parity. (J.F.P.)

39778 ON THE BREAKING OF EFFECTIVE CHIRAL U(3) ⊗ U(3) LAGRANGIAN. Sakuraoka, Mitsuru; Toda, Azuma (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 41: 1260-6(May 1969).

The phenomenological $SU_L(2) \otimes SU_R(2)$ invariant Lagrangian, proposed by Kawarabayashi and Kitakado, in which ρ and A_1 obey nonlinear chiral transformation rules is extended to chiral $U_L(3) \otimes U_R(3)$. Moreover, SU(3) symmetry breaking is introduced into this Lagrangian. Then the mass of K_A meson is predicted. As the chiral partner of K* meson, the $K_A(1320)$ is more desirable than the $K_A(1230)$. The symmetry breaking effects of f_π and $V\Phi\Phi$ coupling constants also are calculated. The decay parameters of K_{13}^+ decay are estimated to be $\xi = f_-(0)/f_+(0) = -0.29 \pm 0.01$, $\lambda_+ = 0.024 \pm 0.001$ and $\lambda_- = 0.024$. (auth)

39779 INVARIANT FUNCTIONS AND DISCRETE SYMMETRIES. I. Hardenberg, K.; Muetter, K.-H.; Theis, W. R. (Freie Univ., Berlin). Nuovo Cim., 62A: 385-400(July 21, 1969).

Complete sets of linearly independent invariant functions for 2×2 scattering processes which are free of kinematical singularities and constraints even when parity and time-reversal invariance is taken into account are presented. (auth)

39780 SU(6) CLEBSCH–GORDAN COEFFICIENTS FOR THE PRODUCT 35 ⊗ 70. Carter, J. C. (Loyola Univ., New Orleans); Coyne, J. J. J. Math. Phys. (N. Y.), 10: 1204-10(July 1969).

A method is presented which makes explicit use of Young diagrams to calculate SU(3) ⊗ SU(2) multiplet-coupling coefficients in SU(6). The multiplet-coupling coefficients for 35 ⊗ 70 are given. (auth)

39781 ON THE WIDTH DISTRIBUTION FOR A COMPLEX SYSTEM WHOSE HAMILTONIAN CONTAINS A SMALL INTERACTION THAT IS ODD UNDER TIME-REVERSAL. McDonald, J. F. (Univ. of Windsor, Ont.). J. Math. Phys. (N. Y.), 10: 1191-4(July 1969).

An approximate expression for the width distribution of a complex system with a small odd term is given. The expression is compared with available Monte-Carlo calculations and seems to be a good approximation for large N ($10 \leq N \leq 100$). (auth)

39782 THE RELATIVISTIC SO(4,2) QUARK MODEL AS A REPRESENTATION OF CURRENT ALGEBRA AT INFINITE MOMENTUM. THE SPECIAL CASE OF CURRENTS PROPORTIONAL TO THEIR RESPECTIVE CHARGES. Pavkovic, Marko Ivan. Irvine, Calif., Univ. of California, 1968. 123p.

Thesis.

Noncompact groups larger than SL(2,c) are considered as the relativistic quark model representations of the current algebra at infinite momentum, in the special case where the currents are proportional to their respective charges. The technique of relying on one single unitary irreducible representation of the noncompact group G, SL(2,c)CG, rather than considering the infinitely reducible representations of SL(2,c) is adopted and used throughout. This is the idea of the dynamical, or spectrum generating group. From this standpoint, G = SL(2,c) is analyzed first. The unitary irreducible representations of the principal series give form factors and transition probability matrix elements as the oscillatory functions of the momentum transfer. The form factors corresponding to the unitary irreducible representations of the supplementary series, though not suffering from the same malady, display in all cases, cut-like, never pole-like analytic form. The location of the singularity is $t = 4M^2$, where M denotes the mass of the particle state. This fact is in obvious discord with the usual dispersion theoretical concepts, where the masses of vector mesons are those that are employed as dynamical variables in the vertex function. It is believed that the discovered deficiences of the SL(2,c) form factors represent sufficient evidence against the use of SL(2,c) in the role of a dynamical group. Next, the group G = SO(4,2), or more precisely, the particular unitary irreducible representation of SO(4,2) is considered. This is the very same representation capable of accommodating all states of the quantum mechanical system of the nonrelativistic H-atom without spin. In the text, this representation describes the infinitely many possible orbital (and radial) excitations of quarks inside the particle. The isovector electromagnetic form factors corresponding to the ground state of the Ξ ($T = \frac{1}{2}$, $Y = -1$) baryon tower are evaluated and compared, using the SU(3) symmetry arguments with the recently measured electromagnetic form factors of the ground state of the nucleon system N($T = \frac{1}{2}$, $Y = 1$). One free real phenomenological parameter can be fixed in such a way as to yield a very close agreement with the experiment — within the limits of the SU(3) symmetry scheme. This success encourages one to speculate about various possible means of testing the predictions of the SO(4,2) relativistic quark model representations of current algebra at infinite momentum against the experiment. (Diss. Abstr.)

39783 DYNAMICAL GROUPS AND THEIR CURRENTS. A MODEL FOR STRONG INTERACTIONS. Barut, A. O. (Univ. of Colorado, Boulder). Ergeb. Exakten Naturwiss., 50: 1-28(1969).

The differences between the group structure of the multiplets and the group structure of interactions are discussed, and models in which these properties are explicitly exhibited are presented. The general framework of the dynamical group theory, its special form in the case of the Dirac particle and the H atom, and its application to hadrons are reviewed. The rest frame group O(4,2) is found to be the most satisfactory for all three cases. Within this framework the rest frame group, the particular representation of it, and the form of the quantum mechanical conserved current specify a particular physical system. Also a quantitative model for hadrons is discussed. This model describes the mass spectrum, the partial decay rates, magnetic moments, the electromagnetic and transition form factors, and the diffraction scattering of hadrons. (J.F.P.)

Field Theories

General

39784 TENSOR VARIATIONAL EQUATIONS IN FIELD THEORY. Minkevich, A. V.; Fedorov, F. I. (Belorussian State Univ., Minsk). Dokl. Akad. Nauk BSSR, 13: 313-15(Apr. 1969). (In Russian).

A covariant variational method in field theory is considered. For this purpose the tensor formulation of the Gauss divergence theorem for four-dimensional space with torsion was obtained from the generalized Stokes theorem. With the help of this, the tensor variational equations in field theory were found. The discussed covariance is not extended to the case in which the field variables have a geometric origin (metrics, torsion). (tr-auth)

Quantum Field Theory

Refer also to abstracts 39627, 39636, 39643, 39678, 39709, 39719, and 39757.

39785 (ITF-69-23) WIGHTMAN FORMULATION FOR THE NONLOCALIZABLE FIELD THEORY. [PART] I. Iofa, M. Z.; Fainberg, V. Ya. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 24p. (In Russian). (CONF-690417-5). Dep.

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

It is shown that in the nonlocalizable field theory with exponential growth of vacuum expectation values in momentum space the Wightman functions preserve a number of properties characteristic of local field theories. It turns out that the holomorphy domains of these functions include the real points — the Iost points. Using the Iost points it is possible to introduce a notion of the quasilocality, to prove the theorems of the equivalence of the weak local commutativity and CPT–invariance and the theorem on the connection of spin and statistics. The theory of asymptotic fields and particles and the proof of existence of the unitary CPT–invariant S–matrix in the nonlocalizable field theory is considered. (auth)

39786 (ITF-69-25) WIGHTMAN FORMULATION FOR THE NONLOCALIZABLE FIELD THEORY. II. THEORY OF ASYMPTOTIC FIELDS AND PARTICLES. Iofa, M. Z.; Fainberg, V. Ya. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 20p. (In Russian). (CONF-690417-6). Dep.

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

It is shown that in the nonlocalizable and consequently nonmicrocausal field theories where Wightman functions increase exponentially in momentum space and satisfy the quasilocality condition it is possible to construct a theory of asymptotic fields and particles i.e., to prove the existence of the unitary CPT-invariant S-matrix. (auth)

39787 (ITF-69-26) ASYMPTOTIC STATES IS NONLOCAL FIELD THEORY. Iofa, M. Z. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 8p. (In Russian). (CONF-690417-7). Dep.

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

The existence of asymptotic states is proved in the nonlocal field theory with a sufficiently rapidly decreasing commutator in space-like directions. (auth)

39788 (NYO-3399-197) QUANTUM THEORY OF THE GENERALIZED WAVE EQUATIONS. [PART] I. Tripathy, Kishor C. (Syracuse Univ., N. Y. Dept. of Physics). May 1969. 39p. (SU-1206-197). Dep. CFSTI.

A systematic analysis of the quantum theory of the infinite-component fields that transform under the combined representations of SL(2,C) (Majorana) ⊗ Dirac was made. A complete set of solutions of the wave equation includes solutions with time-like and space-like momentum. The mass-spectra for the time-like and space-like cases were explicitly calculated. The method makes use of the decomposition of the product representation into reducible representations of the "little" groups SU(2) and SU(1,1). Finally, the quantization of the generalized fields is presented. (auth)

39789 (RLO-1388-553) RENORMALIZEABILITY OF MASSIVE NON-ABELIAN GAUGE FIELDS: A FUNCTIONAL INTEGRAL APPROACH. Boulware, David G. (Washington Univ., Seattle. Dept. of Physics). [1968]. Contract AT(45-1)-1388. 60p. Dep. CFSTI.

The renormalizability of massive non-Abelian vector gauge fields is discussed using a functional integral technique. The ideas are first developed for the case of a neutral vector meson coupled to a conserved current, where the renormalizability holds. The non-Abelian vector field is written as the gauge transform of a four dimensionally transverse field and the transverse and gauge variables are then treated separately. It is shown that the renormalizability depends solely on that of the gauge variables, which are found to be nonrenormalizable; hence, neither is the field theory. The gauge variables alone provide a representation of the σ-model and of Sugawara's theory of currents which are thus shown to be nonrenormalizable theories. (auth)

39790 ALGEBRA OF FIELD IN THE STUECKELBERG FORMALISM. Omote, Minoru; Takaya, Yoshimasa (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto), 41: 202-13 (Jan. 1969).

Recently Lee, Weinberg and Zumino have proposed the algebra of field and derived sum rules for the spectral functions of the vector and axial vector field based on the Yang-Mills theory with mass terms. But in their formalism, the time components of the vector and axial vector fields were eliminated by using identities. Therefore from the viewpoint of relativistic invariance, their treatment is unsatisfactory. To improve this point, the Stückelberg formalism is employed for the vector fields in which the time component of vector field is treated in the same way as the other components. Therefore the relativistic covariance is clear at every step of formulation. However, the equivalence of the two theories can be proved so long as the problems are treated in the subspace of Hilbert space which satisfies the subsidiary condition. (auth)

39791 VECTOR SPACES WITH INDEFINITE METRIC AND POLE-TYPE GHOSTS. Yokoyama, Kan-ichi; Kubo, Reijiro (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 41: 542-59 (Feb. 1969).

A quantum field theory of general pole-type ghosts is formulated by starting from their definitions in state vector spaces with indefinite metric, on the basis of a few field theoretical postulates. The present general formalism holds for an arbitrary multipole ghost including Froissart's dipole and Nagy's tripole ghosts. It is shown that both the Lagrangian and canonical formalisms can be constructed and they are equivalent to each other. (auth)

39792 REPRESENTATION OF THE WIGHTMAN FUNCTION IN TERMS OF TWO-POINT SINGULAR FUNCTIONS. Minami, Masatsugu (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 527-41(Feb. 1969).

The n-point vacuum expectation value is written as the "mass"-superposition of the integral whose integrand is the product of the two-point Δ^+ and $\Delta^{(1)}$ functions. In the three-point case, it is compared with the graph-theoretical representation previously introduced. For $n \geq 4$, the new representation has no relation consistent with the graph in position space, but it is found that the so-called DANAD-surface can be derived in quite a graph-theoretical manner. (auth)

39793 CONNECTION BETWEEN THE ABSORPTIVE PART OF THE SCATTERING AMPLITUDE AND THAT OF THE FEYNMAN INTEGRAL ASSOCIATED WITH THE TETRAHEDRON GRAPH. Minami, Masatsugu (Kyoto Univ.); Miyata, Hideo. Progr. Theor. Phys. (Kyoto), 41: 252-63(Jan. 1969).

It is shown that the mass-superposition of the absorptive part of the Feynman integral associated with the tetrahedron graph with unphysical external masses is of the form quite similar to the integral representation of the absorptive parts of the scattering amplitudes in the general framework of quantum field theory, but the support of the weight function in the former representation is more restrictive than that in the latter. (auth)

39794 REPRESENTATION OF EXTERNAL FIELDS BY MEANS OF COHERENT STATES. Beck, H.; Thellung, A. (Univ., Zurich). Helv. Phys. Acta, 42: 678-84(July 1, 1969).

The artificial introduction of free, classical ("external") electromagnetic fields into quantum field theory can be avoided, Compton equivalence is shown between the conventional free external field method and a description in terms of pure quantum field operators, where suitably chosen photon states simulate the effects of the external field. These states are uniquely determined, they are the coherent states of Glauber. (auth)

39795 A GENERALIZATION OF HAAG'S THEOREM. Streit, L. (Syracuse Univ., N. Y. Univ. of Pittsburgh). Contract AT(30-1)-03829. Nuovo Cim., 62A: 673-80(Aug. 1, 1969).

Haag's theorem is proved without assuming locality or relativistic invariance. (auth)

39796 QUANTUM THEORY OF AN ELECTROMAGNETIC FIELD IN A GYROTROPIC MEDIUM. Mandel'tsveig, V. B.; Shapiro, I. S. Zh. Eksp. Theor. Fiz., 56: 2069-77(June 1969). (In Russian).

It is shown that despite spatial dispersion the quantum field in a medium may be described by a second-order equation for the vector potential. A covariant apparatus is developed and the causal Green function ("propagator") is calculated. Due to the gyrotropic effect the latter function has three poles and contains an antisymmetric (with respect to vector indices) part. (auth)

39797 NEW FORMULATION OF RELATIVISTIC QUANTUM FIELD THEORY. Sudarshan, E. C. G. (Syracuse Univ., N. Y.). Proc. Indian Acad. Sci., Sect. A, 69: 133-61(Mar. 1969).

Quantum field theory is reformulated in such a manner that a complete set of oscillators for modes with both positive and negative energies is introduced. The theory leads to the proper connection between spin and statistics as in the standard formulation, but it implements the time reversal transformation and the TCP transformation as linear unitary transformations. Negative energy particles in the initial states are identified with antiparticles in the final state with reversed motion (and vice versa) as far as scattering amplitudes are concerned. A covariant perturbation theory is developed which yields scattering amplitudes which are essentially the same as in the usual theory. (auth)

39798 QUANTUM-MECHANICAL DESCRIPTION OF TACHYONS AND THEIR INTERACTIONS. Glueck, M. (Univ., Hamburg). Nuovo Cim., 62A: 791-802(Aug. 1, 1969).

A Lorentz-invariant description of quantum scattering processes of tachyons is given. Space-time considerations are used to derive the pole structure of the connected part of the scattering amplitude. (auth)

39799 CANONICAL FIELD THEORY OF CHIRAL SYMMETRY. Ozaki, Shoji. Progr. Theor. Phys. (Kyoto), 41: 1309-27(May 1969).

A canonical field theory of chiral SU(2) × SU(2) current is constructed by using only pseudoscalar mesons. Although equal-time commutators between time and space components of current are derived from canonical commutators of fields and are different from Sugawara's corresponding ones, equations of motion, continuity equation of current and stress tensor are expressed in terms of current densities alone and have the same form as Sugawara's corresponding ones apart from a numerical factor ½. Chiral symmetry breaking term deducing the PCAC hypothesis satisfies the conservation law of stress tensor and does not alter equations of motion. The self-consistency, relativistic covariance, stress tensor conservation, etc., are checked. (auth)

39800 DIAGONALIZATION METHOD OF A HAMILTONIAN IN SECOND-QUANTIZATION. II. APPLICATION: EXAMPLES OF COMPATIBLE SECOND-DEGREE PROGRAMS. EQUIVALENCE OF FERMI AND YUKAWA THEORIES. Andriambololona, Raoelina (CNRS, Marseille). Progr. Theor. Phys. (Kyoto), 41: 1289-1308(May 1969).

The method given in paper I is applied and the problem of the equivalence of the Fermi and Yukawa theories is considered under

the point of view of physical operators. Examples of compatible second degree programs are given and explicitly computed. The different behavior of three models is studied and pointed out. The equivalence of the Yukawa and Fermi theories is investigated by means of the physical operators. The requirement that a first degree program in the Yukawa theory becomes a second degree program in the Fermi theory leads to the well-known result: the renormalization constant Z_3 of the composite boson vanishes. Though the formulation is based on the hamiltonian consideration and thus, the relativistic covariance may be destroyed, it is shown that this difficulty may be removed by the covariant variable of Umezawa and Kawabe. The physical meaning of the structure functions will be given in a forthcoming paper. (auth)

39801 EXTENDED FORMULATION OF QUANTUM ELECTRODYNAMICS. Kitazoe, Tetsuro (Kobe Univ., Japan); Mugibayashi, Nobumichi; Nakawaki, Yuji. Progr. Theor. Phys. (Kyoto), 41: 1366-74(May 1969).

In order to get a solution to the problem revealed in connection with current commutators in the spin-½ quantum electrodynamics, the Lagrangian is extended to a nonlocal but gauge invariant form. The consistency of field quantization, field equations and current commutators is obtained without taking the limit to the local theory. Some specific phenomena are described which the nonlocal theory, though it is noncovariant, will predict. (auth)

39802 NON-LOCAL FIELD THEORY OF THE QUARK MODEL. Sogami, Ikuo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 1352-65(May 1969).

A phenomenological application of the bilocal field theory is attempted to describe composite systems of quark and antiquark. Basic equations consist of modified forms of the Bargmann–Wigner equations with mass operator and a subsidiary condition. The vibrational motion of constituents under the pairing (antipairing) and spin-orbit residual "forces" accounts for approximately the mass spectrum of mesic states established until now. Further, comments are made on interactions among bilocal fields and their quantizations. (auth)

39803 MASSLESS TENSOR FIELDS AND TRIPOLE GHOSTS. II. Yokoyama, Kan-ichi (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 41: 1384-5(May 1969).

A symmetric tensor field $\Gamma_{\mu\nu}$ of massless particles with spin 2 was previously obtained from the standard field $\gamma_{\mu\nu}$ which obeys Gupta's formalism. A vector tripole ghost field C_μ was introduced as a member of a tripole ghost system. It is shown that the new field $\Gamma_{\mu\nu}$ can be chosen to satisfy the following commutation relation in the Landau gauge. (L.B.S.)

39804 QUANTIZATION OF THE GENERALIZED RARITA–SCHWINGER EQUATION. Kimura, Toshiei; Senba, Kei (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 41: 788-800 (Mar. 1969).

It is shown that the gauge invariance of massless spin-$\frac{3}{2}$ field is not consistent with the vector-spinor transformation property of the field components when starting from the ordinary Rarita–Schwinger equation. The assumptions used in the proof are (i) existence of the vacuum state (ii) existence of a unitary representation of the Poincaré group and (iii) analytic behavior of the two-point function. In order to avoid the difficulty the Rarita–Schwinger equation is generalized so that redundant spin-½ parts are contained. The propagator is found with the aid of the reciprocal operator with respect to the linear operation appearing in the generalized field equation. Stueckelberg formalism is also proposed for the generalized system. (auth)

39805 COINCIDING SIMPLE POLES IN THE SCATTERING GREEN'S FUNCTION. Nakanishi, Noboru (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 780-7(Mar. 1969).

The general theory of multiple poles and coinciding simple poles is applied to the Bethe–Salpeter equation after proving the non-existence of fixed poles in the scattering Green's function. The first-order consistency conditions are analyzed in the case of lightlike total 4-momentum and in the unequal-mass Wick–Cutkosky model at the pseudothreshold. The formula for the first derivatives of the eigenvalues at zero energy is reproduced without using the four-dimensional spherical harmonics. (auth)

39806 FIVE CLASSES OF TRANSFORMATIONS OF DIRAC SPINORS. THE FREE-PARTICLE DIRAC EQUATION IS BROUGHT TO "p_0-", "p_1-", "p_2-", "p_3- AND "m-LINEAR" FORMS. Bracken, A. J.; Cohen, H. A. (Univ. of Adelaide). Progr. Theor. Phys. (Kyoto), 41: 816-31(Mar. 1969).

The free-particle Dirac equation has two remarkable features: (1) It is linear in all four components of the energy-momentum p_μ, and also in the mass m. (2) For its solutions there are five distinct simple modes of the invariant scalar product in the momentum representation. A theorem presented by Case is generalized and used to obtain five classes of transformations of the Dirac equation. Every transformation in a given class has two properties characteristic of the class: (1) The linearity in a corresponding one of the five quantities p_μ, m is maintained in the transformed equation. (In this way "p_0-", "p_1-", "p_2-", "p_3- and "m-linear" forms of the Dirac equation are obtained.) (2) A corresponding mode of the invariant scalar product is preserved. Thus all five classes consist of canonical transformations. Included among the "p_0-linear" forms are the Foldy–Wouthuysen–Tani equation, and the one commonly attributed to Cini and Touschek, together with equations appropriate to limiting situations other than the non-relativistic and extreme relativistic ones. The "canonical" form proposed by Chakrabarti is of the "m-linear" type. Belonging to all three of the "p_1-, "p_2- and "p_3-linear" categories is a "p-linear" form of significance for large |p|. (auth)

39807 INFINITE-COMPONENT CAUSAL FERMI FIELDS WITH ARBITRARY MASS SPECTRUM. Mohan, G. (Univ. of Denver). Nuovo Cim., Lett., 1: 809-16(June 1, 1969).

Relaxing previous conditions which apparently rule out a useful field theory transforming according to a unitary representation of the Lorentz group, infinite-component local Fermi fields with arbitrary mass spectrum are explicitly exhibited, and the local stress tensor is constructed. For this purpose an O_4 subgroup is used whose complex extension is equivalent to the chosen O(3,1) Lorentz subgroup of the O(4,2). (J.F.P.)

39808 DYNAMIC STABILITY IN DE SITTER SPACE. Nachtmann, Otto (Univ., Vienna). Oesterr. Akad. Wiss., Math.-Naturwiss. Kl. Sitzungsber., Abt. II, 178: 363-79(1968). (In German).

The dynamics of quantized fields in de-Sitter space of positive curvature are investigated. It is shown that interacting fields in this space will lead to spontaneous creation. The rate however is very low at the present stage of the universe. (auth)

39809 GOOD AND BAD GHOSTS IN QUANTUM ELECTRODYNAMICS. Duerr, H. P.; Rudolph, E. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim., 62A: 411-38(July 21, 1969).

A certain analogy of the indefinite metric in Gupta–Bleuler quantum electrodynamics and the Heisenberg Lee model is indicated. The state space of Gupta–Bleuler quantum electrodynamics and of the Lee model in the Heisenberg limiting case of coinciding V-particle solutions are both characterized by the appearance of unphysical states in the form of ghost couples consisting of two nonorthogonal states of zero norm. A physical interpretation of both theories is obtained by eliminating one of these ghosts, the "bad ghost," by a time-independent projection which in quantum electrodynamics is achieved by requiring the Lorentz condition in the Gupta form, in the Heisenberg Lee model by the condition that physical states must be superpositions of energy eigenstates. The other ghost state, the "good ghost," is not eliminated by this projection but does not contribute to matrix elements of observables due to its vanishing norm. In quantum electrodynamics the admixture of good ghosts to physical states is left arbitrary and reflects the arbitrariness of gages within the Lorentz gage; in the Lee model, however, its admixture is fixed as Heisenberg has shown by securing a physical asymptotic behavior of the scattering states. Virtually both the physical and unphysical states contribute to physical processes since only combined they represent a complete basis of the local operator algebra. The ghosts of quantum electrodynamics with interaction differ from the corresponding ghosts of the free theory. They are related by a nonlocal pseudounitary transformation. Introducing ghost-dressed field operators with the aid of this transformation leads to the Dirac–Schwinger formulation of quantum electrodynamics where the bad-ghost dressing of the source particles produces their Coulomb interaction. A similar elimination of the ghost structure in the Lee model appears to be possible but is not treated. (auth)

39810 FUNDAMENTALS OF WAVE STATISTICS (RELATIVISTIC). Kar, K. C. Indian J. Theor. Phys., 15: 57-64(Sept. 1967). (In Hindi).

A brief account is given of the different methods used in wave statistics for linearizing the second order relativistic Hamiltonian. Of these the relativistic method shows that the linear Hamiltonian is an alternative form of Einstein's second order Hamiltonian. It has been shown previously that on using this linear form the Klein–Nishina formula and formulas of radiative scattering and pair production can very easily be deduced. Thus there is absolutely no necessity for Dirac matrices. It is shown that Dirac could get correct results through matrices only because of his mutually canceling double mistakes. So the matrices should now be buried forever. (auth)

39811 EQUATIONS OF THE DE BROGLIE WAVEFIELD IN THE CASE OF SPHERICAL SYMMETRY. Kulhanek, J.

(Univ. of Windsor, Ont.). J. Math. Phys. (N. Y.), 10: 1152-6 (July 1969).

Two methods of integrating the equations of the de Broglie wavefield are introduced. The first integrating method does not seem to be as suitable for the domain of the microphysics as the second one. According to the second integrating method, the equations of the de Broglie wavefield are solved for the metric with spherical symmetry. In this case, the equations of the de Broglie wavefield admit of a solution which includes both Schrödinger and Hamilton–Jacobi methods of description as particular cases. (auth)

39812 GENERALIZED BOSE OPERATORS IN THE FOCK SPACE OF A SINGLE BOSE OPERATOR. Brandt, Richard A.; Greenberg, O. W. (Univ. of Maryland, College Park). J. Math. Phys. (N. Y.), 10: 1168-76(July 1969).

Generalized Bose operators b which reduce by two the number of quanta of a Bose operator a are studied in the Fock space of a. All representations of the b's as normal-ordered (infinite degree) power series of the a's are found. The unitary operators relating the irreducible components of b to a are also exhibited. The analogous result for $b^{(k)}$s which reduce the number of a quanta by k is given and the limit $k \to \infty$ is discussed. (auth)

39813 OBSERVABLE SINGLE PARTICLE STATES IN QUANTUM FIELD THEORY. Kennedy, Larry Zane. Tucson, Ariz., Univ. of Arizona, 1968. 45p.

Thesis.

An interpretation, proposed by Just, of field theory in the formulation of Wightman is considered. Based on infinitely differentiable wave functions of compact support, this interpretation implies a unique association of a wave function with each observable state, and therefore allows a definition of the transition probability between two states which satisfies causality. For single free particle states, a calculation of the transition probability using gaussian wave functions shows that this interpretation establishes the conservation of momentum, the existence of the classical trajectory, and the quantum mechanical spreading of the wave packet. Also, a more complicated mass distribution yielding two particles is discussed. (Diss. Abstr.)

39814 GREEN–VOLKOV ALGEBRA IN CONFIGURATION SPACE. Govorkov, A. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Ann. Phys. (N. Y.), 53: 349-75(June 15, 1969).

All irreducible representations of the Green–Volkov algebra in the configuration space are realized on the class of certain symmetry many-particle functions. It is shown that any state in these representations can be labeled by the eigenvalues of the "isospin" and its third projection. In the framework of the Green–Volkov parafield theory an electromagnetic interaction, which breaks up "isospin" symmetry, is formulated. A charge–conjugation transformation is reformulated. The manifest matrix transformation from the Green–Volkov parafield to two usual Fermi-fields is introduced. Thus the Green–Volkov field is shown to be equivalent to the usual Fermi-field with "isospin." (auth)

39815 GEOMETRIZATION OF THE RELATIVISTIC VELOCITY ADDITION FORMULA. Brehme, Robert W. (Wake Forest Univ., Winston-Salem, N. C.). Amer. J. Phys., 37: 360-3(Apr. 1969).

If one defines the proper-time component, v_τ, of the coordinate velocity to be $v_\tau = cd\tau/dt$, the expression for the invariant interval between two infinitesimally close events on the world line of a particle leads to an equation $v_x^2 + v_y^2 + v_z^2 + v_\tau^2 = c^2$. Allowing only motion in the x, y plane, it is seen that this equation is that of a sphere of radius c in velocity space. Each possible velocity in the x, y plane is represented by a different point on the surface of a sphere. If an object is observed from a set of inertial frames, all in relative motion with respect to one another in a given fixed direction, the locus of representative points on the sphere forms a great circle. A method is given for relating the relative velocity between two Lorentz frames to the angle between two points on the surface of the sphere for the special case in which all motion lies in the x direction. (auth)

39816 KINEMATICS OF TWO-PARTICLE COLLISIONS IN SPECIAL RELATIVITY. Chow, Yutze (Univ. of Wisconsin, Milwaukee). Amer. J. Phys., 37: 397-9(Apr. 1969).

The kinematics of elastic two-particle collisions may be summarized by the convenient four-vector equation $q = R_\theta p$, where p and q are four-momenta of the same particle before and after collision in the laboratory frame, and R_θ is the rotation induced in the laboratory frame by a two-dimensional rotation of angle θ in the center-of-mass frame. It is shown that this form has the advantage of being conceptually clear and computationally convenient. (auth)

39817 TORQUES AND ANGULAR MOMENTUM ON A SYSTEM AT EQUILIBRIUM IN SPECIAL RELATIVITY. Aranoff, Sanford (Rutgers-The State Univ., Newark, N. J.). Amer. J. Phys., 37: 453-4(Apr. 1969).

Some errors in a previous discussion of torques and angular momentum of a system at equilibrium in special relativity are considered. Each of these errors is analyzed, and in this way some aspects of special relativity are clarified. (J.F.P.)

39818 PROBLEMS IN VECTOR MESON THEORIES. Zimmermann, W. (Courant Inst. of Mathematical Sciences, New York). Ergeb. Exakten Naturwiss., 50: 143-56(1969).

Difficulties which occur in Lagrangian field theory involving vector mesons are considered. Restriction is made to the case of neutral vector mesons for which a fairly complete analysis of the problems can be given. The model of a massive vector field coupled to a conserved current and models of two vector fields which are coupled to the same current are discussed. (J.F.P.)

39819 CURRENT ALGEBRA IN THE FRAMEWORK OF GENERAL QUANTUM FIELD THEORY. Stichel, P. (Univ., Hamburg. Deutsches Elektronen-Synchrotron, Hamburg). Ergeb. Exakten Naturwiss., 50: 100-9(1969).

The discussion of current algebra in the framework of general quantum field theory covers the definition of charges and generalized charges, and the formulation of equal-time limits including equal-time commutators for charges respectively generalized charges and equal-time commutators for currents. Also covered are c-number gradient terms and q-number gradient terms. (J.F.P.)

39820 INTRODUCTION TO THE LAGRANGIAN METHOD. Mueller, Volkhard F. (Univ., Heidelberg). Ergeb. Exakten Naturwiss., 50: 42-52(1969).

An elementary introduction into the Lagrangian formalism of classical field theory is given. Noether's theorem and electrodynamics and gauge transformations are discussed. Also generalized Yang–Mills theories are considered with an application to the isospin-invariant meson–nucleon interaction. (J.F.P.)

Gravitation and General Relativity

Refer also to abstracts 39281, 39632, and 39634.

39821 (ITF-69-21) SUPER-HEAVY PARTICLES IN SCALAR-TENSOR THEORY OF GRAVITATION. Bronnikov, K. A.; Mel'nikov, V. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 17p. (CONF-690417-4). Dep.

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

A self-consistent treatment of a system of the material scalar field and the gravitational field is carried out. The latter is described by means of metric tensor and fundamental scalar field. Solutions are found in the form of Einstein static microuniverses of Stanukovich's "plankeon," or Markov's "maximon" type. It is shown that for a quantum scalar particle to be closed in its own gravitational field it must possess energy not less than $7.5 \cdot 10^{-5}$ dΓ. Its dimensions are in this case of the order of Plank length 10^{-33} cm. Time-dependent perturbations are considered up to the second order. In the first order they appear as harmonic oscillations with three frequencies; in the second order their amplitude may grow linearly. (auth)

39822 COMMUTATOR OF NON-CONSERVED STRESS TENSORS. Ezawa, Yasuo; Kimura, Toshiei (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 41: 563-4(Feb. 1969).

Starting from the most general form of the Lehmann representation of the commutator of the nonconserved stress tensor, it is shown that the nonconserved stress tensor, to be considered as the source of the gravitational interaction, must vanish. It is suggested that the stress tensor be re-defined as a limit of the nonlocal one. (L.B.S.)

39823 SPHERICALLY-SYMMETRIC T-MODELS IN GENERAL RELATIVITY THEORY. Ruban, V. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Theor. Fiz., 56: 1914-28 (June 1969). (In Russian).

Spherically symmetric models of grain matter are considered in the attached reference frame. A general solution of the Einstein equations is obtained ($\Lambda \neq 0$). Along with the Tolman–Bondi–Lemaitre models it contains an additional class of "sphere" T-models with the metrics of a synchronous-attached T-frame ($R = r(\tau)$). These models are an inhomogeneous generalization of an anisotropic cosmological model of the "quasi-closed" type with hypercylindrical spatial cross sections $V_3 = (S_2 \times R_1)$. The T-models of a "sphere" in principle yield a method differing from the closed Fridman model for realizing the maximal mass defect in general relativity theory which equals the total rest mass of

matter. A characteristic of these models is that the gravitational coupling energy of each of the "grains" exactly compensates its rest mass. As a result, the active mass (which is an equivalent of total energy) remains constant with unrestricted growth of the "sphere" and in general does not contain a material contribution. It is of a purely field nature and coincides with the geometrodynamic "mass without mass" of the T-regions of Schwarzschild–de Sitter–Kottler fields in which matter gravitationally is bound and constrained by an extremely strong vacuum field inside the "event horizons" of the Schwarzschild sphere type. It is shown that the "sphere" T-models do not have any classical analogs and their existence and paradoxical properties are due to nonlinearity of GRT, viz., a) to the mass defect which is manifest in a peculiar way via the non-Euclidian nature of the attached space V_3; b) to the presence of T-regions in SSK fields. The main properties and dynamics of the cosmological T-models of a "sphere" ($\Lambda \neq 0$) are discussed in detail; they are classified in accordance with the Robertson scheme for a closed Fridman model in terms of analogous modes O_1, M_1, M_2, A_1 and A_2 of transverse motion of an hypercylinder V_3. It is noted that all physically acceptable solutions with the $\rho > 0$ should possess time singularities of three types: collapse into a line, point or sphere, with the infinite types M_1, A_2 and M_2 isotropizing during the unrestricted expansion. (auth)

39824 POSSIBLE RELATIONSHIP BETWEEN STRONG, ELECTROMAGNETIC, WEAK, AND GRAVITATIONAL INTERACTIONS. Stephenson, L. M. (University Coll., London). J. Phys., A (London), 2: 475–(July 1969).

A possible causal relation among four interactions is developed, based on Dicke's interpretation of Mach's principle. The dimensionless coupling constants which are predicted from this relation are of the correct magnitude. (auth)

39825 SIMPLE RELATION BETWEEN THE RESTRICTED LORENTZ GROUP L_+ AND THE UNIMODULAR GROUP OF ORDER TWO. Massa, E. (Dublin Inst. for Advanced Studies). Nuovo Cim., Lett., 1: 806–8(June 1, 1969).

An alternative form of the equation $\Lambda^i_j = \frac{1}{2}\,\mathrm{Sp}\,(\tau^i A \tau^j A^+)$ for the relation between a matrix $\pm A \in SL(2,C)$ and the corresponding Lorentz transformation $A \in L^{\uparrow}_{+}$ is given. This form may be easily inverted, thus giving a simple technique for constructing the matrix $\pm A$ when Λ is given. (J.F.P.)

39826 ANGULAR-MOMENTUM FLUX FOR GRAVITATIONAL RADIATION TO OCTUPOLE ORDER. Cooperstock, F. I.; Booth, D. J. (Univ. of Victoria, Can.). Nuovo Cim., 62B: 163–70(July 11, 1969).

In the framework of Landau and Lifshitz, the rate at which angular momentum is lost by a bounded matter distribution through the gravitational channel is shown to be $dL^{\alpha\beta}/dt = -\oint (-g)\,\{x^\alpha t^{\beta\gamma} - x^\beta t^{\alpha\gamma}\}\,n_\gamma dS$, where $t^{\alpha\beta}$ is the Landau–Lifshitz pseudotensor. This flux is expressed in terms of the quadrupole and octupole moments of the source in Einstein's linearized approximation. Applied to a spinning rod, the angular-momentum loss is found to be consistent with the energy loss as computed by Eddington. (auth)

39827 EXPERIMENTAL VERIFICATION OF GENERAL RELATIVITY. Langer, Jiri. Pokroky Mat. Fyz. Astron., 13: 333–56(1968). (In Czech).

Fifteen papers on the general theory of relativity were reviewed, examining the data supporting the theory and analyzing potential experiments not carried out as yet. It was emphasized that the Newtonian theory of gravitation has been developed on a small empirical foundation but has been found of great service to astronomers. The single disagreement found between theory and observations, the anomalous shift of the perihelion of Mercury could be explained by making several ad-hoc assumptions. Three classic experiments are reviewed in greater detail: the shift of the perihelion, the curving of the light beams, and the red shift of spectral lines in the central gravitational field. Experiment for the verification of the general theory of relativity centered on the gravitational equation. Experimental studies that would be of special interest for the further clarification of the problem include: measurement of the speed of light in a gravitational field; shift of the perihelion of a planet as the result of the rotation of the central body; precession of gyroscope in a gravitational field; gravitational radiation. The red shift and the concept of the expanding universe does not actually verify experimentally Einstein's theory of general relativity, as it may be explained on the basis of Newton's theory of gravitation. Einstein's predictions agree with observed empirical data that cannot be sufficiently well explained by other theories. (TTT)

39828 TYPE D VACUUM METRICS. Kinnersley, William (California Inst. of Tech., Pasadena, Calif.). J. Math. Phys. (N. Y.), 10: 1195–1203(July 1969).

Using the Newman–Penrose formalism, the vacuum field equations are solved for Petrov type D. An exhaustive set of ten metrics is obtained, including among them a new rotating solution closely related to the Ehlers–Kundt "C" metric. They all possess at least two Killing vectors and depend only on a small number of arbitrary constants. (auth)

39829 FLUCTUATIONS IN THE 3^0K RADIATION. Dautcourt, G. (Institut fuer Relativistische und Extragalaktische Forschung, Potsdam, Ger.). Monatsber. Deut. Akad. Wiss. Berlin, 11: 163–4(1969). (In German).

The physical processes leading to fluctuations in the small angle region ($\lesssim 1$) were investigated. Quantum fluctuations occurring from the thermal origin of the radiation and fluctuations as a result of the gravitational interaction with thermal gravitation radiation possess very small correlation lengths. The fluctuations produced on fluctuating static gravitational fields is very small. A superclustering discussed in connection with an anisotropic quasar distribution can be significant. (J.S.R.)

39830 FIZICHESKIE POLYA V OBSHCHEI TEORII OTNOSITEL'NOSTI. (Physical Fields in the General Theory of Relativity). Mitskevich, N. V. Moscow, Izdatel'stvo Nauka, 1969. 326p.

The investigation of gravitational and other physical fields in Riemannian space is considered. In contrast to previous work, the unified approach to the complete fields is used. Previously published determinations of the energy–momentum of fields in general relativity theory are collected and compared. The problems of gravitational field quantization, the gravitational–electromagnetic analogy, and theories of the fermion field in the presence of gravitation and electromagnetism are analyzed in detail. New results are obtained, and a number of effects are calculated. A review of concepts and the most important methods of gravitation theory is given. The method of chronometric invariants of Zel'man and the bimetric formalism of Rosen are considered, and tetrad and similar concepts of the gravitational field are discussed. (tr-auth)

39831 TYPE D GRAVITATIONAL FIELDS. Kinnersley, William Morris. Pasadena, Calif., California Inst. of Tech., 1969. 127p.

Thesis.

The Newman–Penrose tetrad equations are set up for the principal tetrad of a Type D gravitational field in vacuum. With no further assumptions, the equations are integrated, yielding an exhaustive list of Type D vacuum metrics. The solutions all possess two commuting Killing vectors and depend on from one to four arbitrary constants. The Type D fields with expanding rays are six closely related versions of Kerr-NUT space, the Ehlers-Kundt "C" metric, and a new generalization of the "C" metric possessing rotation. For zero expansion the three Ehlers-Kundt "B" metrics, plus rotating generalizations of each are found. The six Kerr-NUT metrics are interpreted as spinning particles with timelike, lightlike, or spacelike momentum and angular momentum vectors occurring in all possible combinations. The "C" metric is tentatively identified as a gravitational analog of the runaway solutions encountered in electrodynamics, i.e., a point mass executing hyperbolic motion. Next type-D fields with electromagnetism present are considered. It is found that all of the above vacuum metrics can be readily "charged" by adding a nonnull electromagnetic field whose principal null vectors coincide with the gravitational ones. Some interesting generalizations of the Schwarzschild and "C" metrics containing the geometrical optics limit of a null electromagnetic field which propagates along one principal null congruence are also discussed. In the Schwarzschild case they generalize Vaidya's "shining star" metric to include the field of a particle traveling along an arbitrarily accelerated worldline. (Diss. Abstr.)

39832 NEGATIVE MASS: FACT OR FICTION? Gardner, J. W. New Sci., 42: 578–9(June 12, 1969).

Einstein's theory of general relativity permits the intriguing concept of negative mass, though it has never been detected experimentally. If it does exist it might help to explain the prodigious energies of some of the baffling objects found in the sky in recent years. (auth)

39833 A NEW INTERPRETATION OF THE NUT METRIC IN GENERAL RELATIVITY. Bonnor, W. B. (Queen Elizabeth Coll., London). Proc. Cambridge Phil. Soc., 66: 145–51(July 1969).

The NUT metric is interpreted as the field of (a) a mass around the origin of coordinates, and (b) a semi-infinite massless source of angular momentum. (auth)

39834 CONJECTURE REGARDING QUANTIZED GRAVITATIONAL THEORY AND ELEMENTARY PARTICLES. Harris, P.

(Saint Mary's Univ., Halifax, Nova Scotia). Can. J. Phys., 47: 1884-5(Sept. 1, 1969).

The gravitation actional integral is evaluated for the case of a spherical potential surrounding a spherical mass shell particle. The gravitational action integral is quantized in the Bohr approximation, and a relation is found which connects the particle mass and radius to the Hubble constant. (auth)

Scattering Theory

Refer also to abstracts 39690, 39731, 39785, and 39786.

39835 (ITF-69-15) APPLICATION OF SOME THEOREMS FROM THE THEORY OF ANALYTIC FUNCTIONS AND CONFORMAL MAPPING TO THE SCATTERING AMPLITUDE AND FORM-FACTORS. Baluny, V. Z. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 55p. (In Russian). Dep.

On the basis of the Nevanlinne principle a number of bounds on the scattering amplitude and form factors were previously established. The present aim is to give a systematic and detailed survey of these results, though it contains some original results. An introduction is given to the mathematical technique of the theory of harmonic measure and conformal mapping. On the basis of axiomatic analyticity the lower bound for the scattering amplitude at fixed momentum transfer is established and a new method is given for the estimation of the upper bound of the width of the diffraction peak. The upper bound of the radii of elementary particles and the lower and upper bounds of form factors in the space-like region is derived. (auth)

39836 (ITF-69-29) ANALYTICAL CONTINUATION OF THE EXPANSION IN ORTHOGONAL POLYNOMIALS AND THE PROPERTIES OF THE SCATTERING AMPLITUDE. Yatsun, V. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 25p. (In Russian). Dep.

The analytical properties of the expansions in orthogonal polynomials on the basis of their connection with the properties of the corresponding Taylor series with the same coefficients are studied. The results are applied in the investigation of the amplitude structure in the plane of the scattering angle cosine. (auth)

39837 (NYO-3399-196) AN INFINITE SET OF MODELS SATISFYING CROSSING SYMMETRY, DUALITY, AND REGGE BEHAVIOR. Gardiner, C. W. (Syracuse Univ., N. Y. Dept. of Physics). May 1969. 6p. (SU-1206-196). Dep. CFSTI.

A set of models, characterized by two functions, $h(x)$, $\omega(x)$ is given which satisfies the conditions of duality, crossing symmetry and Regge behavior. These models can be written as $G(\alpha(s), \alpha(t)) = \int_0^1 dx\, h(x)\, x^{-\alpha(t)}\, (\omega(x))^{-\alpha(s)}$, and are generalizations of the beta function. The model still considers only resonances of zero width. (auth)

39838 (NYO-4076-3) LORENTZ POLES AND VENEZIANO REPRESENTATION. Domokos, G.; Koevesi-Domokos, S. (Argonne National Lab., Ill.). July 1969. Contract AT(30-1)-4076. 9p. Dep. CFSTI.

The group theoretical structure of scattering amplitudes exhibiting duality is investigated. Veneziano-type representations are obtained if one assumes that the amplitude is dominated by single Lorentz poles in overlapping channels. It is found that duality and irreducibility in overlapping channels are incompatible with each other. (auth)

39839 THE THEORY OF THE SCATTERING MATRIX. FOR THE INTERACTIONS OF FUNDAMENTAL PARTICLES. Barut, A. O. New York, MacMillan Company, 1967. 362p.

The general principles of S-matrix theory are discussed. Group theoretical specifications of the S-matrix are covered in some detail with emphasis on the theory of unitary representations of the inhomogeneous Lorentz group and related calculations. The connection of the group theoretical results with the form of the amplitudes and with observable quantities is considered. Discrete symmetry transformation, analytic continuation and the resultant Gauchy relations, and practical calculations with specific examples are treated. Also fundamental particle processes are discussed including the assignment of quantum numbers, pion-pion scattering $\pi N \to \pi N$, and $\pi\pi \to N\bar{N}$ scattering, electromagnetic and gravitational interactions. (J.F.P.)

39840 DAUGHTER TRAJECTORIES, THE FREEDMAN-WANG CANCELLATION AND MULTIPLE REGGE POLES. Nakanishi, Noboru (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 516-26(Feb. 1969).

The Freedman-Wang cancellation in the backward scattering of unequal-mass scalar particles is analyzed in detail by means of a general theory of coinciding simple poles. As a result, one confirms that the k-th daughter trajectory generally induces a multiple Regge pole of order k + 1. Futhermore, formulas are found for the expansion coefficients of the trajectory functions $\alpha_k(s)$ and the reduced residue functions $\beta_k(s) = \Sigma_m s^{-k+m}\beta_k(m)$. The expressions for $\alpha_k'(0)$, $\alpha_k''(0)$, $\beta_k(0)$ and $\beta_k(1)$ are calculated explicitly. A general consideration is made on the number of dynamical parameters involved in $\alpha_k(m)(0)$ and $\beta_k(m)$. (auth)

39841 MULTIPLE POLES IN THE OFF-SHELL SCATTERING AMPLITUDE. Naito, Seichi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 41: 500-15(Feb. 1969).

The scattering problem of two spinless particles interacting through a massive scalar field is considered in the ladder approximation. The off-shell scattering amplitudes of these particles are analytically continued from the real axis to the imaginary axis in both the initial and final relative energy planes. In particular, amplitudes on the imaginary axes are considered, assuming that they satisfy the Bethe-Salpeter equation in a Euclidean space. Then, the scattering amplitudes in the zero total energy-momentum case are obtained rigorously as functions of coupling constants. These functions have no singularities except for simple poles in the variable of coupling constants. On the other hand, the scattering amplitudes in the massless case $P_\mu = (0, 0, P_0, P_0)$ can be obtained in a series expansion in powers of P_0, by starting from the scattering amplitudes in the zero energy-momentum case. Then, it is shown that only simple and multiple poles exist in the massless amplitudes at those values of the coupling constants, for which the zero energy-momentum amplitudes are singular. The order of the above multiple poles is equal to or lower than $L - |m| + 1$. Here, m is the helicity of the massless bound state and L is the maximum value of $|m|$. Residues of the N-th order multiple poles are expressed in a power series in P_0, by starting from the power $P_0^{(N-1)}$. Finally, it is shown that multiple poles always exist in the equal-mass case, while they exist in the unequal-mass case only when massive bound states are not degenerate with respect to angular momentum. (auth)

39842 GENERAL THEORY OF MULTIPLE POLES AND COINCIDING SIMPLE POLES. Nakanishi, Noboru (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 233-51(Jan. 1969).

It is investigated in the general framework of the Bethe-Salpeter formalism how multiple poles of the scattering Green's function are synthesized out of coinciding simple poles. A necessary and sufficient condition for the existence of the leading multiple pole is obtained and applied to some concrete examples. The residues of multiple poles and the corresponding generalized Bethe-Salpeter amplitudes are expressed in terms of the residues of simple poles and the ordinary Bethe-Salpeter amplitudes, respectively. Some comments are made on the conspiracy problem from the standpoint of the multiple-pole theory. (auth)

39843 VALIDITY OF THE HIGH ENERGY APPROXIMATION FOR MEDIUM ENERGIES. Tikochinsky, Y. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Lett., 29B: 270-1(May 26, 1969).

A new exact representation for the elastic scattering amplitude is derived. Application of the high energy approximation to the new amplitude yields Glauber's result. The present derivation, however, shows that Glauber's amplitude should be useful down to medium energies. (auth)

39844 ARE ABSORPTIVE CORRECTIONS INCOMPATIBLE WITH UNITARITY? Caneschi, Luca (Univ. of California, Santa Barbara). Phys. Rev. Lett., 23: 254-6(Aug. 4, 1969).

It is found that absorptive corrections to production amplitudes can generate, through unitarity, absorptive corrections to two-body amplitudes. (auth)

39845 SIMPLE FACTORIZABLE MULTI-REGGE MODEL. Frazer, W. R.; Mehta, C. H. (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett., 23: 258-61(Aug. 4, 1969).

Using the multiperipheral integral equation in a factorizable approximation, a simple model can be constructed in which Regge poles and cuts can be studied. In a one-pole version one can obtain a bootstrap of a Regge trajectory and residue function. In a two-pole version a formula is obtained in which the amplitude consists of a Regge pole plus the Amati-Fubini-Stanghellini cut. (auth)

39846 REMARKS ON THE CONVERGENCE PROBLEM OF THE GENERALIZED PARTIAL WAVE EXPANSION. Murai, Nobuyuki (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 41: 191-201(Jan. 1969).

The generalized partial wave expansion in terms of irreducible representations of the inhomogeneous Lorentz group is investigated in the O(3,1) (t = 0) case. If we are concerned only with

transformations of energy-momentum, the scattering amplitude is shown to be a function on K H/K, where H is the little group determined by t and K is the maximal compact group of H. It is suggested that the scattering amplitude which does not belong to $L^2(H)$ has an irreducible component of the supplementary series, and an example is shown. A Hilbert space $\mathscr{H}^0$ larger than L^2 is introduced and Plancherel's formula on $\mathscr{H}^0$ is explicitly shown. The Hilbert space $\mathscr{H}^0$ has the elements corresponding to the supplementary series as well as those of the principal series. (auth)

39847 SPIN FLIP AND POLARIZATION IN SCATTERING OF HIGH ENERGY PARTICLES. Levintov, I. I. Zh. Eksp. Theor. Fiz., 56: 2155-7(June 1969). (In Russian).

It is shown that if rescattering is taken into account in the eikonal approximation, asymptotic spin flip effects (A and R parameters) should not, at small values of q, depend on the energy and nature of the incident particles. (auth)

39848 INDEFINITELY RISING TRAJECTORIES AND GELL-MANN'S PROGRAM. Casabuoni, R. (Univ., Florence); Gatto, R.; Longhi, G. Nuovo Cim., Lett., 2: 166-70(Aug. 1, 1969).

An algebraic realization of an indefinitely rising trajectory was previously presented. In order to understand the relation of this approach to the Gell-Mann program of saturating the current algebra commutators at infinite momentum in the Hilbert space of single-particle states and the possible differences the conserved currents of the model are constructed, a formal quantization is made of the infinite-component field, and the current commutators are derived from the canonical commutators and compared with the corresponding commutators of current algebra. The main conclusion is that the commutators of current time components exhibit explicit Schwinger terms. Their presence avoids any contradictions with general statements asserting the unavoidability of spacelike solutions in the realizations of current algebra. It is suggestive that such a priori unobjectionable modification of current algebra offers possibilities of making the Gell-Mann program workable. Additional speculations are given as to possible ambiguities in the definition of the currents and their possible uses. (J.F.P.)

39849 ALGEBRAIC REALIZATION OF FAMILIES OF INDEFINITELY RISING TRAJECTORIES. Casalbuoni, R. (Univ., Florence); Gatto, R.; Longhi, G. Nuovo Cim., Lett., 2: 159-65 (Aug. 1, 1969).

An infinite-component wave equation is presented which leads to a linearly rising trajectory; also a wave equation leading to an infinite family of parallel and linearly rising trajectories is presented. From the mass spectra for these equations it is shown that for the physical representations there are no spacelike and no lightlike solutions of continuum spin. It is shown that such systems are equivalent to hydrogenlike models with potentials of energy-dependent strength. (J.F.P.)

39850 ON THE SOLUTIONS OF THE BETHE-SALPETER EQUATION IN THE UNEQUAL-MASS WICK-CUTKOSKY MODEL IN THE MOVING SYSTEM. Seto, Kenji (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto), 41: 1340-51(May 1969).

The stereographic projection method is applied to obtain the bound state amplitude in the moving system of the Bethe-Salpeter equation in the unequal-mass Wick-Cutkosky model. The timelike, spacelike, lightlike and spurionlike solutions are derived from the one in the moving system. The normalization properties of these solutions are also discussed. (auth)

39851 CANCELLATION OF THE SINGULARITIES OF THE BACKWARD UNEQUAL-MASS REGGE-POLE TERMS. Minami, Masatsugu (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 1328-39(May 1969).

In terms of the contour integrals in the s plane, the Kim-Resnikoff cancellation mechanism with moving poles is studied to the extent that it can be identified with that of Freedman and Wang. The method of the contour integrals is also suggested to be appropriate in understanding the multiple-pole theory recently given by Nakanishi. (auth)

39852 PRODUCT STRUCTURE OF MEASUREMENTS. Jacobson, D. A. (Douglas Advanced Research Labs., Huntington Beach, Calif.). Nuovo Cim., 62B: 139-52(July 11, 1969).

In the case of particle momentum measurements, loosely speaking, the result of a multiparticle measurement is the direct product of the result of several single-particle measurements. This built-in product structure for particle momentum measurements forms the basis for a simple presentation of the decomposition principle or cluster structure of the S-matrix. Previously the formulation of an S-matrix theory valid for arbitrary measurements was begun. In order to introduce the decomposition principle into this theory, it is first necessary to investigate the product structure of arbitrary measurements. The fundamental properties of such a product structure are derived from a postulate describing the way two states can be combined to form a single compound state. (auth)

39853 LORENTZ POLES AND MOMENTUM TRANSFER DEPENDENCE OF REGGE RESIDUES. Riordan, F. (Univ. of Birmingham, Eng.). Nuovo Cim., Lett., 1: 804-5(June 1, 1969).

The transition amplitude is found to be a sum of terms for each representation of the Poincaré group in the two-particle state products. A pole in one of these terms corresponds to a pole in a series of the terms labelled by total spin. The residue of the pole is related to the residues of the poles labelled by angular momentum. The same analysis is carried out in the cross channel, and it is found that a Lorentz pole is a sum of Regge poles with residues dependent on the direction of energy-momentum not just its magnitude, when the particles have spin and masses which are not pairwise equal in the cross channel. (J.F.P.)

39854 NO-GO THEOREM FOR THE UNEQUAL MASS SL(2C) CLASSIFICATION OF REGGE POLES. Riordan, F. (Univ. of Birmingham, Eng.). Nuovo Cim., Lett., 1: 801-3(June 1, 1969).

It was previously proposed that for null momentum transfer, to preserve analyticity of the scattering amplitude for particles with spin and masses which are not equal pairwise in the cross channel, Regge poles should be classified according to the SL(2C) group as in the general case. The higher group is not the little group but for each value of the momentum transfer p, a representation of it contains a representation of the little group. Let the representation be $G_{n\sigma,n\sigma}(g;p) = G(g_1,g_1,p)$, where $g \subset SL(2C)$ and σ runs over the $2j_n + 1$ values of the spin-z component for each n, and n labels the spin multiplets in the tower representation of SL(2C). The representations for different p are assumed to be equivalent so there exists a unitary matrix B(p) such that $G(g;p) = B^{-1}(p)G(g,0)B(p)$, $B \equiv 1$. Moreover j_n subspaces must be unmixed by B(p) since j_n is assumed to be a Lorentz invariant. It is shown that except in the spinless case when $j_n = 0$ for all n the above assumptions are inconsistent with the Lorentz transformation properties of the G's. (J.F.P.)

39855 POLES IN THE IMPACT PARAMETER PLANE. Dean, N. W. (Cavendish Lab., Cambridge, Eng. Vanderbilt Univ., Nashville). Nuovo Cim., 62A: 604-14(July 21, 1969).

The possibility of poles in the impact parameter plane is considered by using a formulation due to Islam to make clear the difference between the Henzi definition of the amplitude and that of Adachi and Kotani. As an example, the impact parameter representation of a Regge pole is studied in both formalisms. Although it appears probable that only cuts are present in the impact parameter plane, pole terms may nonetheless provide reasonable approximations to large-angle scattering. Good agreement with experiment is obtained in fits to the pp data near 90° using simple parametrizations of the residue and trajectory functions. (auth)

39856 S-MATRIX AND CLASSICAL DESCRIPTION OF INTERACTIONS. Iagolnitzer, Daniel (Centre d'Etudes Nucleaires, Saclay, France). J. Math. Phys. (N. Y.), 10: 1241-64(July 1969).

It is shown quite generally, through a correspondence between S-matrix and classical descriptions of particle states and of their measurements, that an S-matrix theory actually leads, under appropriate conditions, to the classical space-time description of interactions, involving the usual classical concepts and formulas. (auth)

Particle Accelerators

Refer also to abstracts 38299, 38308, 39291, 39293, 39592, and 39995.

39857 (AERE-Trans-1113) THE CLOSED ORBIT OF THE SERPUKHOV 70-GeV SYNCHROTRON, AS DETERMINED BY GEODETIC SURVEYS OF THE MAGNET SECTIONS. Runov, I. V.; Khanamiryan, A. E.; Shukeilo, I. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by E. W. Kendall (Atomic Energy Research Establishment, Harwell, Eng.), from report IFVE-SKU-68-8-K. 11p. Dep. CFSTI. UK 2s. 6d.

The results of the precision survey of the spatial positions of the 70 GeV proton synchrotron magnet units made during Dec. 1966-Oct. 1967 are given. Four surveys of the magnet units in vertical positions and two surveys in radial positions were performed. The closed orbit distortions, according to the survey data do not exceed ±5 mm and ±7 mm in the vertical and radial directions respectively. (auth) (UK)

39858 (CERN-69-15) TRANSVERSE OSCILLATIONS OF A RELATIVISTIC PARTICLE BEAM IN A LAMINATED VACUUM

CHAMBER. Zotter, B. (European Organization for Nuclear Research, Geneva (Switzerland)). June 9, 1969. 41p. Dep.

Coherent transverse oscillations of relativistic particle beams may limit the number of particles that can be contained in accelerators and storage rings. In order to calculate the limit of stability one needs to know the electric and magnetic fields caused by the oscillating beam. These fields exert an electromagnetic force on the beam particles, which may be expressed by the dispersion relation coefficients U and V for the in-phase and out-of-phase components. While the in-phase component only shifts the betatron frequency—which may cause problems if resonances are crossed—the out-of-phase component will always give rise to instability in a monochromatic beam. The instability may be suppressed by a proper amount of energy and/or amplitude spread. The dispersion relation coefficients for vacuum chamber walls consisting of several layers of material are discussed. A method is described which allows the calculation of U and V for a cylindrical beam surrounded by an arbitrary number of concentric layers, each layer being characterized only by three material constants: permeability, permittivity, and conductivity. The dispersion relation coefficients are evaluated numerically, and analytic expressions are found in the long wavelength limit for not too complicated wall configurations. Simple walls consisting of ceramic, Ferrite, or metal are discussed, as well as metal walls of finite thickness and metallized ceramic walls. Also the influence of structures outside the vacuum chamber is investigated. The results are presented in the form of graphs of the dispersion relation coefficients for typical ISR parameters. Of special interest is the fact that a metal wall thinner than the skin depth will have a strong influence on U and V, even for the smallest thicknesses that can be produced in practice. In general, both U and V will be much larger than for a thick wall. (auth)

39859 (CONF-681064-3) APPLICATIONS OF LINEAR ACCELERATORS IN NUCLEAR INDUSTRY. Kelliher, Maurice G. (Vickers Ltd., Swindon (England). Radiation and Nuclear Engineering Div.). [1968]. 11p. Dep.

From British Nuclear Forum and Deutsches Atomforum Meeting, Frankfurt am Main, Germany.

The applications of electron accelerators discussed are the determination of neutron capture and scattering spectra of materials, the effects of high γ-doses on materials, and the x-ray examination of thick pressure vessels. The layouts of some installations are illustrated. (UK)

39860 (CONF-690401-, pp 143-54) USE OF A PROCESS CONTROL COMPUTER SYSTEM IN ANALYSIS OF NEUTRON CROSS SECTION DATA AND THE CONTROL OF NEUTRON DATA ACQUISITION FACILITIES AROUND A VAN DE GRAAFF AND AN ELECTRON LINEAR ACCELERATOR. Horstmann, H.; DeKeyser, A.; Schmid, H. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau).

A description of an IBM 1800 computer-based data processing system for neutron cross section measurements at a 90 MeV electron linear accelerator and a 3 MeV Van de Graaff accelerator is given. The data acquisition system includes an IBM 729/IV magnetic tape unit. Both on-line and off-line data processing are described. (W.H.K.)

39861 (COO-1760-2) SUMMARY REPORT ON CYCLOTRON UTILIZATION, OPERATIONAL ACHIEVEMENTS, AND IMPROVEMENTS DURING TWELVE MONTHS ENDING MAY 31, 1969. Technical Progress Report. (Washington Univ., St. Louis, Mo.). July 16, 1969. Contract AT(11-1)-1760. 18p. Dep. CFSTI.

Development and operation of the Washington University cyclotron from June 1, 1968, to May 31, 1969, are summarized. (W.H.K.)

39862 (LA-4148) TEST OF COMBUSTION-PRODUCT DETECTORS IN A RADIATION ENVIRONMENT. Putnam, Thomas M.; Parker, Joseph R. (Los Alamos Scientific Lab., N. Mex.). Mar. 1969. Contract W-7405-eng-36. 12p. Dep. CFSTI.

Ionization-type combustion-product detectors proposed for early warning fire detectors at the Los Alamos Meson Physics Facility (LAMPF) were tested for response to an electrical fire in an accelerator-produced radiation environment. Three each of six different models were tested. The results show that this type of detector will not work in this environment. (auth)

39863 (MSUCP-15) ION INJECTION IN A CYCLOTRON WITH DOUBLE-MODE DEE SYSTEM. Reiser, M. (Michigan State Univ., East Lansing. Cyclotron Project). Feb. 1963. 51p.

For the MSU cyclotron a double-mode dee system is being planned with two 144° dees and two dummy dees operating for first- and third-harmonic acceleration in the push-pull mode and for second-harmonic acceleration in the push-push mode. The characteristics and possibilities of such a system with respect to ion injection and central-region layout are investigated. In particular two injection schemes are studied: (a) a normal-injection scheme in which ion source and puller are readjusted radially and azimuthally when the mode of operation is being changed to optimize starting conditions and beam quality; (b) a dc-injection scheme where the ion source is on a high dc potential and the ions are injected at a fixed point in all 3 modes of operation. The computations show that in the normal-injection scheme very favorable conditions with respect to beam quality and ion-capture efficiency can be achieved for all modes of operation. In the dc-injection case only the results for the first-harmonic mode are favorable while the situation in the cases of second- and especially third-harmonic acceleration is extremely unsatisfactory (poor beam quality and low ion-capture efficiency). (auth)

39864 (MSUCP-16) INITIAL ACCELERATION AND RADIAL FOCUSING IN THE NONUNIFORM ELECTRIC FIELD AT THE ION SOURCE OF THE CYCLOTRON. Reiser, M. (Michigan State Univ., East Lansing. Cyclotron Project). Mar. 1963. 30p.

The electric field in the median plane between ion source and extractor electrode was mapped in a 10:1 scale for various geometric arrangements with the conductivity-paper method. Initial trajectories, energy gain, transit time and radial focusing of the ions in this field region were calculated numerically (neglecting space-charge effects). The calculations disclosed that the nonuniform field produced by the cylindrical arc chamber of the conventional ion source causes a very strong distortion of the radial beam shape. This defocusing effect can be substantially reduced if the arc chamber is flattened at the side facing the extractor electrode to make the field more uniform. Further improvement is possible by recessing the source face at the output slit, in which case a very favorable parallel-beam situation can be achieved. In addition, by proper shaping of the recess, the defocusing effects of space charge and convex plasma boundaries can be balanced out. (auth)

39865 (MSUCP-17) CYCLOTRON DUTY-FACTOR IMPROVEMENT BY REDUCTION OF PHASE BUNCHING IN THE CENTRAL REGION. Reiser, M. (Michigan State Univ., East Lansing. Cyclotron Project). Mar. 1963. 32p.

In an isochronous cyclotron, if negative ions are accelerated and beam extraction is accomplished by electron stripping, the duty cycle of the transmitted beam is essentially determined by the phase-bunching effect in the central region, the radial stability limit of the magnetic field, and the tolerable maximum spread of kinetic energy at deflection radius. The effect of phase grouping and the associated spread of orbit centers are analyzed for different situations of central geometry in the case of conventional as well as d.c. injection. The results of the calculations show that it is possible to substantially reduce the phase-bunching effect, which is the main cause for the low duty factors in conventional cyclotron beams, and produce a central beam with a pulse length approaching 180° by (a) operating at low magnetic fields and high dee voltages to increase the orbit radius on the first turns, (b) limiting the electric field to a narrow gap by attaching diaphragms to the dees in the center, and (c) if necessary employing a d.c. injection scheme. (auth)

39866 (NAL-26) DESIGN PROGRESS AT THE NATIONAL ACCELERATOR LABORATORY, 1968-1969. Livingston, M. S. (National Accelerator Lab., Batavia, Ill.). June 30, 1969. 41p. Dep. CFSTI.

The continuing changes in design of the 200-GeV accelerator and its associated facilities are described for the historical record. (auth)

39867 (ORNL-TM-2662) INTRODUCTION TO THE STATE OF HEAVY-ION ACCELERATOR PROJECTS. Livingston, Robert S. (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 33p. (CONF-690707-1). Dep. CFSTI.

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany.

The early history of acceleration of heavy ions is reviewed. Tables have been compiled of typical performance for present day heavy ion accelerators of various types. Data showing typical performance of several ion sources have been plotted. A review is made of the potentialities and limitations of the most common accelerator systems. A list of known proposals for new accelerators is presented. (auth)

39868 (SLAC-105) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, January 1-March 31, 1969. (Stanford Linear Accelerator Center, Calif.). June 1969. Contracts AT(04-3)-400; AT(04-3)-515. 80p. Dep. CFSTI.

A status report on the Stanford Linear Accelerator Project covering the period January 1, 1969 to March 31, 1969, is presented. Topics included are accelerator and research area operations, accelerator and research area equipment development, and physics research equipment development. (auth)

39869 (UCRL-Trans-1398) COLLECTIVE METHODS OF ACCELERATION. Rabinovich, M. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated by Benjamin Thayne for Univ. of California, Lawrence Radiation Lab., Berkeley, from report NP-17918. 54p. Dep. CFSTI.

Basic physical problems involved in collective acceleration methods, electron rings, electron streams, plasma accelerators, magnetic-dissipation method of acceleration, the linear plasma betatron at the Technical Institute of the Academy of Sciences of the USSR, and the radiation method of acceleration are discussed. (W.H.K.)

39870 (UJV-2177-A) OPTICAL CHARACTERISTICS OF A QUADRUPOLE LENS PAIR. Franc, P. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). May 1969. 11p. Dep.

Equations are presented to solve the problems of astigmatic image forming using a pair of quadrupole magnetic lenses. The method may also be used for a pair of electrostatic quadrupole lenses. (W.H.K.)

39871 (UJV-2178-F) FOCUSING PROPERTIES OF HOMOGENEOUS MAGNETIC FIELD BOUNDARY. Frants, P.; Krzhemenek, Ya. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Apr. 1969. 27p. (In Russian). Dep.

The focusing properties of a uniform magnetic field pole-edge, acting on a beam of charged particles, were investigated analytically. The focal curves were found for the straight edge and the resolving power was computed as a function of energy. More details, such as the influence of the source, slits, and detector dimensions are discussed also. Formulas are presented suitable for the design of charged particles magnetic analyzers. (auth)

39872 CALCULATIONS OF DOUBLE-FOCUSING PARTICLES BY QUADRUPOLE LENS DOUBLET IN Y-152-2 CYCLOTRON. Irisbaev, K. N. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 2, 20-2(1969). (In Russian).

Double-focusing particles were calculated using optical anology approximation equations for determining the distance from the source and double-focusing image at various gradients for each magnet. The experiments considered the length of each magnet equal to 0.34 m and the distance between the magnets 0.56 m. Obtained data were programmed for every possible image and source in the operational range of the magnetic lens gradients. (R.V.J.)

39873 THE LOS ALAMOS MESON FACTORY. Rosen, Louis (Los Alamos Scientific Lab., N. Mex.). Sci. J., 5A: 39-47(July 1969).

An accelerator that will produce particle beams thousands of times more intense than hitherto is now being built in New Mexico. It should provide new knowledge about the structure of the nucleus, help solve radiation damage problems and open up new methods of treating tumors. (auth) (UK)

39874 ADVANCES FOR LINEAR ACCELERATORS. Reischle, J. Elektrotech. Z., B, 21: 130(Mar. 21, 1969). (In German).

At room temperature linear accelerators may be operated only in a pulsed mode because of electrical losses, but a superconducting accelerator permits almost continuous operation and gives high secondary currents of high-energy particles. An operation temperature of 1.8°K is required, and the efficiency is only 0.6% at this point. A unit set up at Karlsruhe by the Gesellschaft fuer Kernforschung requires less energy because cold is achieved by a piston expansion machine which is more efficient at small output than the expansion turbine. The smaller circulating quantities thus have smaller thermodynamic losses and a smaller compressor; the unit is cheaper in construction and in supply. Cooling to 80°K is achieved with N_2, cooling to 9°K by Claude evaporation in a piston expansion machine, and to 1.8°K by the Joule-Thomson effect. (BBB)

39875 2-N POLE ELECTROMAGNET FOR FOCUSING CHARGED PARTICLES. Beth, R. A. (to U. S. Atomic Energy Commission). U. S. Patent 3,461,410. Aug. 12, 1969.

A cylindrical, 2-n pole, transverse field producing magnet and means for cancelling the external field of the magnet while enhancing the internal field thereof are described. In one embodiment having shim stepped stabilized superconductors approximating a smoothly varying current sheet function for focusing charged particles, a cylindrical laminated, magnetically permeable, low reluctance, outer member extending beyond the ends of the magnet, substantially cancels the external field of the magnet while uniformly increasing the transverse field produced thereby. (AEC)

39876 NEGATIVE-ION BOMBARDMENT OF INSULATORS TO ALLEVIATE SURFACE CHARGE-UP. Andersen, C. A.; Roden, H. J.; Robinson, C. F. (Applied Research Labs., Goleta, Calif.). J. Appl. Phys., 40: 3419-20(July 1969).

Methods and results of bombarding a dielectric target with a negative ion beam of several kilovolts without observing charging effects are described. An illustrative example is given of sputtered positive aluminum ions ($^{27}Al^{+}$) from pure aluminum and from aluminum oxide bombarded with negative oxygen ions ($^{16}O^{-}$). (W.H.K.)

39877 NEUTRON GENERATORS. Bounden, John Ellery; Large, Leslie Noel (to United Kingdom Atomic Energy Authority). U. S. Patent 3,448,314. June 3, 1969. Priority date Mar. 11, 1965, Great Britain.

A neutron generator is described which comprises a normally sealed-off envelope, means for producing a plasma in a gas within a portion of the envelope, and an electrode bounding the envelope. Ions are extracted from the plasma through an aperture and pass through an extractor electrode and target shield, each having aperatures in register with the boundary electrode aperature to allow passage of the ion beam. An axial magnetic field is produced in the region of the boundary electrode aperture, and a target is located behind the target shield. (L.T.W.)

39878 FRASCATI MICROTRON AS SYNCHROTRON INJECTOR. Bizzarri, U.; Branca, G.; Letardi, T.; Maccioni, M.; Morselli, F.; Vignati, A. (CNEN, Frascati, Italy). Nuovo Cim., Lett., 1: 820-2(June 1, 1969).

The development and performance of a 10- to 12-MeV microtron for use as injector to increase the beam intensity of the Frascati electron synchrotron are described. The principal advantages from the use of the microtron are an increase in the maximum beam intensity from $6(10)^{11}$ e.q./m to $6(10)^{12}$ e.q./m, a reduction in the number of magnet-correcting coils, which permits a change in beam energy to be more easily made, a very high increase in the stability of the beam intensity, acceleration of the beam using only one fixed-frequency R.F. system, simplification of the operational program for capturing the first few turns, and easier and cheaper maintenance. (J.F.P.)

39879 STORAGE-RING ION TRAP DERIVED FROM THE LINEAR QUADRUPOLE RADIO-FREQUENCY MASS FILTER. Church, D. A. (Univ. of Washington, Seattle). J. Appl. Phys., 40: 3127-34(July 1969).

The storage of protons and ^{3}He ions in a circular storage-ring ion trap with background gas collision-limited loss time constants up to 8 min long under ultrahigh-vacuum conditions is described. Storage-ring traps were derived from the linear quadrupole rf mass filter by shaping the electrodes into circular and racetrack configurations. Operation of the traps with a trapping rf frequency Ω large compared to the secular ion oscillation frequency ω inhibited ion loss due to nonlinearities in the trapping fields. Long-term ion storage in such traps may prove useful for radio-frequency ion spectroscopic purposes. (auth)

39880 MULTISECTION ACCELERATING TUBE. Serbinov, A. N. (Physico-Energetic Inst., Obninsk, USSR). Prib. Tekh. Eksp., No. 2, 20-2(Mar.-Apr. 1969). (In Russian).

It is shown that accelerating tubes with gradient fields consisting of three-element sections of equal length possesses the advantages of both sectional tubes and tubes with elements of equal length. (tr-auth)

39881 THERMAL AND NONTHERMAL PLASMA FOR THE GENERATION OF IONS HAVING A HIGH IONIZATION DEGREE. Franke, Hermann; Kranigk, Helmut. Wiss. Ber. AEG-Telefunken, 41: 183-90(1968). (In German).

Spectroscopic electron and gas temperature measurements, whose principles are described, are used together with measurements of the extracted ion currents, the characteristics and the axial electrical fields of the LT arc in the magnetic field in order to ascertain whether or not the thermal or nonthermal plasma is better suited to generate ions of high ionization stage at reasonable technical complexity. In molecular gases the amounts of reaction heat conductance aggravate heating the plasma. A thermal plasma assumes higher gas pressures or very high discharge currents. On ion extraction high gas pressures cause charge reversing losses: Magnetic fields, which could give rise to contraction of the plasma, influence the beam quality of the extracted ions. Heating the plasma to a temperature in excess of 10,000°K proves very difficult under the given boundary conditions. Under these conditions nonthermal plasma seems far simpler, in which at low gas pressures the electron density and electron tempera-

ture may be changed independent of each other, so that optimum conditions are given for the generation of highly ionized ions. (auth)

39882 IONOPTIC INFLUENCES OF ASYMMETRIC MAGNETIC FIELDS ON EXTRACTION FROM CYCLOTRONS. Mahrt, Rudolf; Mueller, Rolf W. Wiss. Ber. AEG-Telefunken, 41: 190-9(1968). (In German).

Both for the design of extraction systems for cyclotrons as well as for their quantitive appreciation it is desirable to possess a measure for the optical quality of the transformation of a certain ion transit path if higher field derivatives and, in particular, field asymmetries play a part. For appraisal we may start from a suitable defined phase space and attempt to describe the transformation with adequate accuracy by means of matrices of finite degree. Whereas these matrices have been familiar for linear transformation for a long time, they were extended recently to transformation of higher degree, too. Using the method to be described it is possible to determine quantitively the influence of smaller field asymmetries as originate from imperfections of construction and material and to calculate the optical transformation with accurate knowledge of the field components disturbing the symmetry. In most cases these data are difficult to determine by measurement. However, the method allows appreciation of the effect of certain types of field disturbance in respect of their strength and distribution and thus the estimation of tolerances for design accuracy and material quality as well as of the risk on the use of definite beam guiding devices. Thirdly, beam deformations, e.g., on observation of luminescent screens or photo plates, may be checked for their validity as probable assumed field defects. Terms of zero order are introduced in the coefficient scheme (matrix) of the transformation and in the matrix display of the equation of motion, in which the field distribution is taken into consideration. The differential equation for the transformation matrix is integrated numerically. Before the method is applied to an example, the effect of the various elements of the transformation matrix on the distortions of the beam configuration is discussed qualitively. The mathematical discussion of the applicability of the method is given separately as appendix 1, likewise the representation of the multiplication rules for the combination of two or more representation paths. In appendix 2 the conditions are examined ad hoc, under which quadratic or higher degree developments of non-linear transformation are true to volume. (auth)

39883 TARGET DEVICE FOR PARTICLE ACCELERATORS. Fujiwara, Seiichi (to Mitsubishi Heavy Industries Ltd.). Japanese Patent 1969-7200. Mar. 18, 1969. Filed Oct. 15, 1965.

In the medical particle accelerator, the accelerated electrons are either directly used or the x rays produced by the electron-ray bombardment are used, to irradiate lesions of patients. By the method proposed, the target area, including the paths of both the electrons and the x rays, can be compact, and the cooling of the target can be improved. Where the beam of electrons or x rays is taken out for lesion irradiation, a small chamber is installed in which the x ray producing target plate is placed at right angles to the oncoming electron-beam; partitions are used in the chamber, to form the paths of coolant for the target. The electron beam from the accelerating tube is deflected appropriately, either to hit the target or to go out directly; the exit for the x rays and the electrons is one and the same. (NSA of Japan)

39884 PARTICLE ACCELERATOR. Kikuda, Masanao (to Mitsubishi Heavy Industries Ltd.). Japanese Patent 1969-8478. Apr. 3, 1969. Filed Oct. 20, 1965.

The proposed particle accelerator is used for medical purposes, namely, to irradiate lesions with accelerated particles from all radial directions, the lesions being the center of the circular plane. The obtained advantages are the high particle energy and the high density beam with the compact construction of the whole device, thereby leading to the low cost of the medical irradiation facility, and the easy and precise irradiation of the lesion from all radial directions. The accelerating tube is set horizontally on the supporting upright rods standing on the floor. The output end of the accelerating tube is extended in two steps, that is, by two tubes connected together; the first tube runs upward, then the second tube runs horizontally in the forward direction. The accelerated beam from the accelerating tube is deflected 90° at each bend, and also at the end of the second tube (here, deflected downward toward the lesion of a patient). The extension of two tubes, in the shape of a crank, can be rotated with respect to the fixed accelerating tube, to permit the irradiation from all radial directions. (NSA of Japan)

39885 DEVICE FOR SUPPLYING POWER TO A CHARGED-PARTICLE ACCELERATOR. Monoi, Tsutomu (to Tokyo Shibaura Electric Co.). Japanese Patent 1969-12795. May 27, 1969. Filed July 24, 1965.

The proposed device concerns the capacitor to couple the high-frequency amplifier to the cavity resonator in a synchrotron, for example. The advantages are elimination of a corona discharge between the electrodes of the coupling capacitor, and non-breakage of the high vacuum in the accelerating tube even if a discharge occurs. The device includes the following: a circular accelerating tube with high vacuum; cavity resonators, arranged in the accelerating tube; a high-frequency power source to supply power to the cavity resonators; a high-frequency amplifier; and the coupling capacitor to connect the amplifier to the cavity resonator. The coupling capacitor is made, as follows: (1) The cavity resonator is a double-walled cylinder, forming a part of the circular accelerating tube. (2) A hole is cut in the inner wall, and an outward short cylinder is set so as to cover this hole, with the other end of this short cylinder being closed. (3) A cylindrical electrode is set within the outer cylinder, fixed onto the cavity wall; another cylindrical electrode, telescoping into the other electrode, is fixed onto the inside of the short-cylinder end. (NSA of Japan)

39886 TARGET FOR PARTICLE ACCELERATORS. Hagiya, Miyoshi (to Hitachi Ltd.). Japanese Patent 1969-7199. Mar. 18, 1969. Filed Jan. 29, 1965.

In particle accelerators in general, for medical or research purposes, the accelerated particles such as electrons or positive particles are either directly used, or the x rays or neutrons, produced by bombardment of targets, are used. By the method proposed, the target can be compact and its cooling can be improved. A target in the shape of a circular plate is held at the end of a double-walled tube. In the double-walled tube, the central tube, after running through the outer tube, goes around the circular-plate target, and then opens into the space between the two walls of the double-walled tube. Cooling water flows through the said path, coming back into the said space, and it goes out of the double-walled tube at a point a little distance from the target plate. The circular target, fixed at the end of the double-walled tube, can change its posture by rotating the double-walled tube itself, so that it faces the beam of accelerated particles, or moves away from the beam. (NSA of Japan)

39887 SYNCHROTRON. Tawara, Hiroyuki (to Hitachi Ltd.). Japanese Patent 1969-12796. May 27, 1969. Filed July 9, 1965.

In synchrotrons in general, it is required to accelerate and produce a high-intensity charged-particle beam, for physics studies, etc. For this purpose, the high-intensity beam is usually pre-accelerated before injection into a synchrotron. With this high-intensity, however, the charged particles are disturbed in pre-acceleration because of the large space charge; furthermore, to converge this pre-accelerated beam into a synchrotron, extremely large power must be supplied. By the method proposed, these drawbacks can be removed. To obtain the necessary pre-accelerated high-intensity beam for injection into a synchrotron, a plurality of pre-accelerators and the corresponding deflectors are used; and the respective produced beams of accelerated particles are injected together into the synchrotron. In this way, a large-intensity pre-accelerated beam can be obtained easily, and furthermore, even when a failure occurs to the pre-accelerators, the operation of a synchrotron can be continued. (NSA of Japan)

39888 DEVICE FOR ACCELERATING CHARGED PARTICLES. Utsunomiya, Shinpachi (to Tokyo Shibaura Electric Co.). Japanese Patent 1969-12788. May 27, 1969. Filed Aug. 30, 1965.

In the charged-particle accelerating device proposed, a plurality of accelerated charged-particle beams is obtained from a plurality of the corresponding accelerating tubes, with a common (accelerating) ac power source; the acceleration is done by ac. In supplying ac power to the respective accelerating tubes, a conducting cylindrical structure is used, instead of a cable not suitable for the purpose; the over-all construction is simple and low-cost. The charged-particle accelerating device consists of the following: a tank, containing an accelerating ac power source and a power source to supply power for charged-particle emission, etc.; a plurality of tanks, containing an accelerating tube with means for charged-particle emission, etc.; a plurality of cylinders connected between the two tanks, those cylinders are detachable from either or both of the two tanks; and conducting cylindrical structures installed within the connecting cylinders, to supply accelerating ac power to the accelerating tubes and other power for charged-particle emission, etc. (NSA of Japan)

39889 PARTICLE ACCELERATORS. Timm, U. (Deutsches Elektronen-Synchrotron, Hamburg). pp 245-67 of Atome, Kerne, Elementarteilchen. Suessmann, Georg; Fiebiger, Nikolaus (eds.). Frankfurt am Main, Umschau Verlag, 1968. (In German).

The history of the development of particle accelerators is outlined, with a brief description of cascade and band generators,

linear accelerators, circular accelerators, the cyclotron, synchrocyclotron, betatron, synchrotron, and storage rings. (J.S.R.)

39890 CRITICAL CURRENTS OF RELATIVISTIC ELECTRON BEAMS. Bogdankevich, L. S.; Zhelyazkov, I. I.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 57: 315-20(July 1969). (In Russian).

The critical currents of relativistic electron beams in drift space are considered. It is shown that for a noncompensated beam the limiting current restricted by the volume charge linearly increases with electron energy in the relativistic limit. In compensated beams the critical currents can be determined from the condition of appearance of electrostatic instabilities in the system. In this case with increasing electron energy in the relativistic region the critical currents grow as E^3; this presents an opportunity of obtaining large currents in compensated relativistic electron beams. (auth)

39891 RADIAL AND AXIAL BETATRON OSCILLATION AMPLITUDE SPECTRA IN THE DUBNA SYNCHROCYCLOTRON. Danilov, V. I.; Enchevich, I. B.; Polferov, E. A.; Rozanov, E. I.; Safonov, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods, 72: 285-90(1969).

A method for the determination of the radial and axial betatron oscillation amplitudes of the synchrocyclotron beam particles is described. This method has made it possible to find the distribution of particles as a function of the amplitude (an oscillation spectrum). For the Dubna synchrocyclotron the values of radial and axial betatron oscillations at the full radius are 15 and 2 cm, respectively. (auth)

39892 STUDY OF THE CHARGE CHANGE HEAVY ION ACCELERATOR. Miessner, H. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 72: 269-76(1969).

A feasibility study is presented on the heavy ion accelerator proposed by Hortig. The obtainable beam current is estimated as $\approx 10^{10}$ uranium particles/sec · MeV. A double tube version with separated accelerating and decelerating sections is proposed. This system is found to have some significant advantages. (auth)

39893 EMISSION REGULATOR FOR USE IN HIGH INTENSITY ELECTRON-IMPACT ION SOURCE. Hubbard, R. E.; Bohn, M. J.; Leventhal, J. J. (Univ. of Missouri, St. Louis). Nucl. Instrum. Methods, 72: 351-2(1969).

A versatile, low cost, easily constructed electron emission regulator for use in the production of stable high intensity beams is described, and the results of stability tests reported. (auth)

39894 ION SOURCE. Tawara, Hiroyuki (to Hitachi Ltd.). Japanese Patent 1969-12790. May 27, 1969. Filed June 21, 1965.

The ion source, as usual, includes the following: a cylindrical, intermediate electrode, whose one end converges to a small hole and on the other end an ion-emitting filament; an anode plate, in front of the intermediate electrode, with a small hole, corresponding to the hole in the intermediate electrode; an electrode with a central hole corresponding to the other two holes in front of the anode, to draw out the beam of ion from the intermediate electrode through the anode; and the windings around the cylindrical, intermediate electrode, to provide a magnetic field for containing the ions in a confined space. By the method proposed, the aligning of the holes in the intermediate electrode and the anode, and also the adjustment of the distance between the two electrodes, can be done easily, without breaking the vacuum. The end plate, with a filament on it, of the cylindrical intermediate electrode is extended into a larger circular plate; its circumference is bent forward to form a short cylinder with a flange. A bellows connects the flange of this short cylinder to the anode plate. Bolts and nuts hold the anode and the intermediate electrode in position. (NSA of Japan)

39895 HIGH-FREQUENCY ION SOURCE. Akatsu, Yoshi (to Hitachi Ltd.). Japanese Patent 1969-12789. May 27, 1969. Filed Feb. 19, 1965.

The proposed high-frequency ion source is used for particle acceleration such as the Van de Graaff accelerator or the Cockcroft-Walton's machine. In this type of ion source, a plasma is produced in the chamber by a discharge, and the charged particles are ejected for acceleration by an anode through a slit in front. By the method proposed, the adverse effect of attachment of metal powder or graphite around the anode and outlet slit due to spattering can be removed, and it leads to the lengthened life of a high-frequency ion source. The discharge tube, in which a gas is ionized, is an oblong dome; at the top end is a cathode, and at the bottom end a plate with a charged-particle outlet slit in the middle. Midway between the two ends, around the circumference of the discharge tube, a ring-shaped electrode, connected to a high-frequency power source, is installed, and on the inside wall of the discharge tube, corresponding to the position of the external high-frequency electrode, another ring-shaped electrode is installed. (NSA of Japan)

39896 CHARGED-PARTICLE ACCELERATING TUBE SHIELDED AGAINST THE MAGNETIC FLUXES. Tsuji, Yoshio (to Sumitomo Electric Industries, Ltd.). Japanese Patent 1969-12792. May 27, 1969. Filed Nov. 29, 1965.

In a certain type of charged-particle accelerator, the accelerating tube is set in parallel with the mechanism of generating a high voltage by means of transformers. By the method proposed, this accelerating tube can be shielded against the magnetic fluxes, leaking from the high-voltage generating mechanism; the result is the keeping of a charged-particle beam being accelerated along the central axis of the accelerating tube. The charged-particle accelerating tube is constructed by arranging alternately ring-shaped electrodes and short insulating cylinders, with a packing between. This accelerating tube produced is enclosed in a similarly shaped body of an insulating, magnetic-conducting material, to shield against the leaking magnetic fluxes. As the magnetic-flux shielding material, ferrite of the Ni-Zn system may be used. (NSA of Japan)

39897 MECHANISM FOR FINELY ADJUSTING POSITIONS IN A LINEAR ION ACCELERATOR. Nakada, Shozo (to Mitsubishi Electric Mfg. Co.). Japanese Patent 1969-12794. May 27, 1969. Filed Apr. 28, 1965.

The mechanism proposed is for adjusting finely the position of members, e.g., a cylindrical electrode, in the accelerating cavity of a linear accelerator. The advantages obtained are reduction of the loss in the power due to the flow of high frequency current into the adjusting mechanism, and the maintaining of a high vacuum in the cavity; furthermore, the construction is simple and the handling is easy. The mechanism consists of the following: the cavity body, lined with copper; a hole, cut through the cavity wall; a short cylinder, inserted into the hole, with a flange at the outside end; a flange, surrounding the part of the short cylinder inside the cavity wall, fixed onto the copper lining; means to give a good contact between the lining and the flange and between the short cylinder and the flange, respectively; a bellows, connected to the end of the inner flange, extending along the axis of the hole; a plate with a central hole, sealing the end of the bellows; a position-adjusting rod, inserted into the short cylinder and through the bellows and the central hole; and a member, e.g., a cylindrical electrode, fixed at the top of the position-adjusting rod (these are all made of copper). (NSA of Japan)

39898 PARTICLE ACCELERATOR. Suematsu, Shigeru (to Hitachi Ltd.). Japanese Patent 1969-10800. May 1, 1969. Filed Mar. 22, 1965.

In the particle accelerator (Cockcroft-Walton's machine) proposed, the smoothing condensers are protected adequately from discharges occurring in the high-pressure tank. As usual, the accelerator includes condensers, rectifiers, smoothing condensers, the high-voltage electrode, an accelerating tube, the accelerating electrodes, shield plates, etc. To protect the smoothing condensers, the following procedure is used: The equalizing shield-plates surround the high-voltage generating structure and the accelerating tube. Safety resistors are set between the smoothing condensers and the shield plates to the accelerating electrodes. By the installation of safety resistors in this way, the smoothing condensers are protected as follows: When a spark discharge occurs from the shield plate to the high-pressure tank, and a current flows from the smoothing condenser to the shield plate, the discharge is restricted by the safety resistor. When a discharge occurs between the accelerating electrodes, and a closed circuit is formed with the smoothing condenser, shield plate, electrodes, etc., the current is restricted by the safety resistor. (NSA of Japan)

39899 DEVICE FOR CONTROLLING THE HIGH VOLTAGE IN PARTICLE ACCELERATORS. Suematsu, Shigeru (to Hitachi Ltd.). Japanese Patent 1969-10799. May 1, 1969. Filed Feb. 19, 1965.

The device proposed for controlling the high voltage is applied for the type of high-voltage generator in which condensers and rectifiers are arranged alternately, for example, the Cockcroft-Walton's machine. The advantages obtained are elimination of the deterioration in high-voltage control with the lapse of time and the change of temperature; the control is accurate and the construction is simple. The high-voltage control device includes the following: a high-voltage dc source; a high-voltage electrode; an accelerating tube; a high-pressure tank containing these three; an electrode to detect the voltage electrode, installed close to the inner surface of the pressure tank, facing the high-voltage electrode; and a voltage-control circuit to control the high-voltage dc source corresponding to the voltage detected by the electrode. Accurate control of the high voltage is necessary, to obtain the

predetermined intensity and energy of an accelerated particle beam. (NSA of Japan)

39900 AMPLITUDE INHOMOGENEITY OF THE BETATRON MAGNETIC FIELD. Anokhin, V. P.; Kononov, B. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 104-9(1969). (In Russian).

The influence of betatron magnetic field amplitude inhomogeneity on the forced and betatron radial electron oscillations during extraction (dumping on the target) at the final acceleration cycle is analyzed. The dynamics of the amplitudes and betatron radial oscillation phases were studied using analog-digital computer. (tr-auth)

39901 DEVICE FOR ACCELERATING PARTICLES. Masuda, Seizo (to Tokyo Shibaura Electric Co.). Japanese Patent 1969-8479. Apr. 3, 1969. Filed Dec. 16, 1961.

In the particle accelerator proposed, an ion pump is used as an auxiliary, to obtain a high vacuum in the accelerating tube, for example, of a Van de Graaff or a Cockcroft–Walton machine. The ion pump, enclosed in a pressure-resistance structure, is located within the high-pressure vessel filled with nitrogen, etc.; it is not damaged by the external pressure. Because of the high vacuum obtained in the accelerating tube, problems such as the decrease in the accelerated-particle output, and the scattering of an ion beam can be eliminated. The device includes the following: the accelerating tube consisting of an ion source, the high voltage electrode, and an evacuating device located on the lower voltage side of the tube; the high-pressure vessel filled with an inert gas, containing the accelerating tube, etc.; a vacuum chamber of strong structure, opening into the accelerating tube, located within the high-pressure vessel; and an ion pump as the auxiliary, contained in the vacuum chamber, consisting of a cathode of a getter material, and a pair of electrodes energized by dc high voltage. (NSA of Japan)

39902 DEVICE FOR ACCELERATING ELECTRONS. Okumura, Masayuki (to TDS Electronics Co.). Japanese Patent 1969-9560. May 2, 1969. Filed July 3, 1964.

The method proposed is applicable to such electron accelerators as the betatron and synchrotron which require ac excitation. The advantages are the high acceleration of electrons, regardless of the fluctuation in frequency of a commercial electric current and its change from one region to another. Because of the use of semiconductor control elements as the switching elements, the failures and the power expenditure in the switching circuit are fairly reduced. The device for accelerating electrons includes the following: a smoothing circuit to commutate a commercial alternating current; the switching circuit, consisting of the semiconductor elements having central electrodes with a push-pull connection, making the primary coil supplied with the dc voltage from the smoothing circuit of the accelerator electromagnet the load; a trigger oscillation circuit in which the oscillation period is regulated with a resistor and a condenser; a flip-flop circuit operated with the output of the trigger oscillation circuit; and the trigger circuit. (NSA of Japan)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 38284, 38308, 39562, 39568, 39877, 40314, 40451, and 40453.

39903 (CONF-690401–, pp 633-49) NEW NON-MULTGROUP ADJOINT MONTE CARLO TECHNIQUE. Levitt, Leo B. (Atomics International, Canoga Park, Calif.); Spanier, Jerome (North American Rockwell Corp., Los Angeles, Calif.).

An adjoint technique which appears to be very useful for solving problems in the slowing-down region below the threshold for inelastic scattering is described. The physically intuitive basis for this technique is by means of an exact reversal of direct Monte Carlo random walks, including the preservation of scattering angles. This idea was previously used in a combined direct-adjoint Monte Carlo calculation of resonance integrals. It is shown that this reversal may be also accomplished by a transformation of the adjoint transport equation by means of a discontinuous importance function which, in each region of the problem, is the flux in an infinite medium of scatterer appropriate for that region. From the latter point of view this transformation may be seen to be a logical extension of continuous energies of the adjoint multigroup formulation of Spanier and Gelbard. In addition to the variance reduction it achieves, the principal advantages of the adjoint technique stem from its ease of implementation, computational speed, and its ability to utilize the same nuclear data as an equivalent direct Monte Carlo calculation. The new technique considerably expands the range of problems tractable by Monte Carlo. It seems particularly well-suited, for example, to the analysis of foil experiments and computational times appear to be sufficiently low to permit parametric studies to be performed cheaply. (auth)

39904 (NIJS-P-235) INFLUENCE OF ANISOTROPIC SCATTERING ON THE NEUTRON DIFFUSION COEFFICIENT IN HETEROGENEOUS SYSTEMS WITH PERIODIC STRUCTURE. Pregl, G. (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). Dec. 1968. 46p. (In Slavic). Dep.

The time-dependent monokinetic transport equation with linearly anisotropic scattering law is partially solved for a periodic lattice. The method applied is based on three-dimensional Fourier transform of the transport equation in which the cross sections are expressed by two-dimensional Fourier series. Explicit expressions are derived for the anisotropic diffusion coefficient of a square lattice with cylindrical empty channels. The main difference compared to previous theoretical results is in the expression for the diffusion coefficient parallel to channels. The quadrupole term is important in this case. Measurements are reported together with all known experiments on systems with empty channels. Special attention is devoted to the functional dependence between the decay constant and the size of the system. The expression for the parallel component which is derived is in good agreement with experimentally determined values. Hence, the discrepancy between the experimental data and the theoretical predictions can be regarded as resolved. The expression for the perpendicular component of the diffusion coefficient is in accord with the previous theoretical results and agrees with the experimental values. (auth)

39905 (TW-63) ANISOTROPIC MULTIGROUP TRANSPORT THEORY. Shultis, J. Kenneth (Groningen Rijksuniversiteit (Netherlands). Mathematisch Instituut). [1968]. 29p. Dep.

A method for solving various infinite-medium and half-space multigroup transport problems with anisotropic transfer is presented. A set of eigen-solutions for the homogeneous multigroup equations is obtained and is shown to have "full-range" completeness and orthogonality properties. These properties then can be used to solve for the infinite medium Green's function. Half-space problems are solved in two distinct steps. First, the emergent distribution is calculated. Then, application of the full-range completeness property gives the complete solution everywhere in the half-space. The success of this method implies that the eigen-solutions also possess a "half-range" completeness property. (auth)

39906 (UCRL-71584(Rev.1)) COMPUTERIZED LIBRARY AND EVALUATION SYSTEM FOR INTEGRAL NEUTRON EXPERIMENTS. Hampel, Viktor E.; Howerton, Robert J.; Wade, John A. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 5, 1969. 6p. (CONF-690609-3). Dep. CFSTI.

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash.

A computerized library of references to integral neutron experiments was developed at LRL. This library serves as a data base for the systematic retrieval of documents describing diverse critical and bulk nuclear experiments. The evaluation and reduction of the physical parameters of the experiments to a standard numerical format and their comparison with calculated results using Monte Carlo computer codes and established libraries of neutron cross sections will make routine appraisal easier and also make possible improvement of neutron transport calculations. (auth)

39907 THE MEASUREMENT OF FAST NEUTRON ENERGY SPECTRA IN LIQUID NITROGEN BY THRESHOLD DETECTOR TECHNIQUES. Allen, Earl Wayne. Los Angeles, Univ. of California, 1968. 224p.

Thesis.

Threshold detector foils were employed to evaluate the intensity and energy spectrum of fast neutron fields in liquid nitrogen. The fast neutron fields were generated by a D-T neutron source inserted into a pool of liquid nitrogen. Threshold detector measurements were made by immersing metal foils in the bulk liquid at distances up to 40 cm from the source, which corresponds to $1\frac{1}{2}$ mean free paths for D-T neutrons in liquid nitrogen. Ten threshold reactions, which had energy threshold between 0.3 MeV and 13.5 MeV, were utilized. The neutron-induced activities of the threshold detector foils were measured using both beta counting and gamma counting techniques. Surface barrier detectors were used for the beta measurements. A NaI(Tl) scintillation detector was used for the gamma measurements. Both types of detectors were calibrated independently by standard radioisotope sources and cross-calibrated with one another by activated threshold detector foils. An analytical technique for estimating the fraction of beta particles escaping from a metal foil was developed. The technique was based upon a straight-ahead transmission model which used beta range data to evaluate transmission factors along straight-line paths from a point source. Transmission factors obtained in this manner were averaged over solid angle and over the foil thickness to estimate the fraction of beta particles escaping from the foil. The calculated foil factors were found to fit the experimental data to within a few percent for the foil thicknesses utilized. The available reaction cross section data for the threshold reactions of interest were compared and evaluated. The evaluated threshold detector cross section data for nine of the threshold reactions were found to yield results which were consistent to within ±5% for unmoderated D-T neutrons. The results for the $^{115}In(n,n^*)^{115m}In$ reaction were found to be dependable only within ±10% because of difficulties in isolating the activity of ^{115m}In. The differential neutron spectra evaluated from threshold detector data were found to be consistent and realistic. The experimental removal cross section for D-T neutrons in nitrogen was found to be in excellent agreement with the best available nitrogen cross section data. Inelastic scattering by nitrogen was, however, found to produce much larger neutron energy degradations than predicted by neutron transport analyses based upon available nitrogen cross section data. The differential neutron spectra derived from threshold detector measurements were found to exhibit a minimum between 9 and 11 MeV below the source energy. The calculated differential neutron spectra exhibited minima that were only 4 to 5 MeV below the source energy. It was concluded that this discrepancy was caused by inadequacies of the inelastic scattering models used to generate multigroup cross sections for nitrogen. Although liquid air was not utilized in these experiments, the experimental program using liquid nitrogen clearly demonstrated the feasibility of using this type of simulation experiment to evaluate the characteristics of fast neutron transport in the atmosphere. (Diss. Abstr.)

39908 FIRST-FLIGHT CORRECTIONS AND SECOND ORDER AGE THEORY. Bhamidipaty, Udaya Bhaskara Sarma. College Park, Md., Univ. of Maryland, 1968. 108p.

Thesis.

From the general Boltzmann equation, second order "Age" equations are developed, from which the expression for neutron "Age" is obtained. The anisotropic scattering coefficients entering the second order "Age" equations are also derived. Numerical values of neutron "Age" are obtained using first and second order "Age" theory expressions. Expressions for the "First-flight" correction for plane parallel and point sources, monoenergetic and distributed energy spectra, are derived by using Fermi's continuous slowing-down diffusion model. The equations for the slowing-down density including the "First-flight" corrections are first derived and the corresponding second and fourth moments are then obtained. All these expressions are developed in multigroup form to improve the accuracy of evaluating "First-flight" corrections. The numerical values of the "First-flight" corrections are then obtained. Usually the reported values of neu-

tron "Age" are obtained either by measurements or by calculations using numerical-analytical methods (excluding the "Age" theory method). These values differ significantly (often by as much as 20 to 30 percent) from those values obtained using the "Age" theory. Most of the reported values of "Age" (identified as uncorrected values) neglect the "First-flight" corrections. The numerical values of these corrections calculated (in the present study) are applied to the reported "Age" (uncorrected) values and the corresponding corrected values of "Age" are obtained. These corrected values differ by 3 to 5 percent from the values obtained using "Age" theory. It is therefore concluded that the discrepancies which previously existed between the reported values of "Age" and the values obtained using "Age" theory are due to the omission of the "First-flight" correction. Further, the results of the present study establish that the magnitude of these "First-flight" corrections is significantly higher than those previously considered. The numerical values of these corrections obtained using different descriptions of the fission spectra indicate that if source spectrum weighted cross sections are used, the "First-flight" corrections are insensitive to small errors in the description of the source spectrum. (Diss. Abstr.)

39909 POLARIZATION ANALYSIS OF THERMAL-NEUTRON SCATTERING. Moon, R. M.; Riste, T.; Koehler, W. C. (Oak Ridge National Lab., Tenn.). Phys. Rev., 181: 920-31 (May 10, 1969).

A triple-axis neutron spectrometer with polarization-sensitive crystals on both the first and third axes is described. The calculation of polarized-neutron scattering cross sections is presented in a form particularly suited to apply to this instrument. Experimental results on nuclear incoherent scattering, paramagnetic scattering, Bragg scattering, and spin-wave scattering are presented to illustrate the possible applications of neutron-polarization analysis. (auth)

39910 EPITHERMAL-NEUTRON SPECTRUM DETERMINATION USING A PLURAL FOIL. Dekker, A. L. (Delft Univ. of Tech., Netherlands). Nucl. Appl., 7: 179-82(Aug. 1969).

A modification of the cadmium-difference technique is described in which a plural foil consisting of thin evaporated resonance probes is used for rapid and simple epithermal neutron spectrum measurements. (D.C.W.)

39911 THE DEPENDENCE OF THE NEUTRON TEMPERATURE ON THE GEOMETRIC PARAMETER FOR WATER AND LOOSE DIPHENYL. Bayer, R.; Cervena, J.; Schaeferlingova, W. (Nuclear Research Inst., Rez, Czech.). Czech. J. Phys., 19: 911-17(1969).

The dependence of the neutron temperature T_n on the geometric parameter B^2 was measured by the pulse method in water and diphenyl. The measurements were made on a moderator poisoned by cadmium sulfate, a substance whose absorption cross section is non 1/v. (auth)

39912 SOME CALCULATIONS ON THERMALIZATION OF NEUTRONS IN GRAPHITE. Ghatak, A. K.; Bansal, N. K.; Goyal, I. C. (Indian Inst. of Tech., New Delhi). J. Nucl. Energy 22: 636-9(Oct. 1968).

Multigroup diffusion theory calculations on the time-dependent neutron spectra in graphite are reported. Satisfactory agreement was found with the experimental results of Kameko and Sumita [NSA 20: 13728] and Hewitt and Walker [NSA 22: 29885]. A calculated mean lifetime in graphite was compared with the high-energy values of Williams [NSA 18: 26513]. (UK)

39913 QUASI-CLASSICAL THEORY OF SLOW NEUTRON SCATTERING. Nishigori, Takeo; Sunakawa, Sigenobu (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 41: 619-34(Mar. 1969).

A new quasi-classical formula of the scattering cross section of a slow neutron is proposed. The formula satisfies the constraint of detailed balance and takes the recoil effect fully into account. When the dynamics of the target particles are described by the linear equation, the classical cross sections do coincide with those based on exact quantum mechanical calculations. (auth)

39914 NONLINEAR INTEGRAL EQUATION WITH APPLICATIONS TO NEUTRON TRANSPORT THEORY. Pazy, Amnon; Rabinowitz, Paul H. (Stanford Univ., Calif.). Arch. Ration. Mech. Anal., 32: 226-46(Feb. 20, 1969).

A nonlinear integral equation is studied and a theory developed and applied to problems from neutron transport theory and branching diffusion processes. The theory is used to handle the nonlinear integro-differential equation from the theory of neutron transport. This equation describes a nuclear reactor in which a neutron moves in straight line segments with a given speed between any 2 collisions with the atoms of the reactor. The neutron has a positive probability of leaving the reactor between any 2 collisions. In a collision, it has a probability of being absorbed and probabilities of being replaced instantaneously by new neutrons starting from the point of the collision and having random directions. The extinction probability of this neutron, i.e., the probability that injecting the neutron at a given position with a given direction will lead to a reactor without any neutrons after a certain amount of time, can be defined. The solution of the equation represents the probability that a neutron injected into a nuclear reactor produces a persisting chain reaction. Finally, an application to branching diffusion processes is suggested, and nonlinear parabolic initial-boundary value problems are considered, and solutions lying between 0 and 1 are sought. (BBB)

39915 DIFFUSION AND EXTRAPOLATION LENGTHS OF THERMAL NEUTRONS IN WATER BY A STATIONARY METHOD. Martinho, E.; Salgado, J. (Laboratorio de Fisica e Engenharia Nucleares, Sacavem, Portugal). J. Nucl. Energy, 22: 597-600 (Oct. 1968).

A water-filled Perspex container was placed on a 1-cm Perspex plate in contact with a reactor thermal column. The cadmium ratio of the source was about 180. Measurements of the neutron flux were made by gold foils. At a water temperature of 24°C an extrapolation length of 0.37 ± 0.02 cm and a thermal neutron diffusion length of 2.794 ± 0.009 cm were derived. (UK)

39916 DECAY OF A THERMALIZED NEUTRON PULSE IN GRAPHITE. Hanna, N. N.; Harris, M. J. (Univ. of Manchester, Eng.). J. Nucl. Energy, 22: 587-96(Oct. 1968).

The thermalized neutron density decay was measured in 17 graphite stacks, the B^2 value of which ranged from 2.99×10^{-3} cm^{-2} to 25.30×10^{-3} cm^{-2}. The neutron pulse strength of a SAMES type J deuteron accelerator was raised by a factor of one hundred, careful spatial harmonic analysis was performed, waiting times of the order of 2 m sec used, and very thorough shielding procedures adopted. It was found that a single decay constant, λ, characterized even the smallest stack used. Fitting these values of λ to a polynomial in B^2 indicated that the role of the B^4 term is negligible, and that $D_0 = 2.103 \pm 0.019 \times 10^5$ cm^2 sec^{-1}, $C = 33.78 \pm 1.22 \times 10^5$ cm^4 sec^{-1} for graphite of density 1.685 g cm^{-3} and temperature 20.7°C. These results were in good agreement with other recent investigations. Although this polynomial fit included points well above the theoetrical $\lambda_{1/m}$, (2600 sec^{-1}), the parameters derived were independent of B^2 range. It is suggested that, although polynomial fitting to points above $(B^2)^*$ is not strictly valid, it is a meaningful and useful procedure for graphite at room temperature, and for $B^2 < 25 \times 10^{-3}$ cm^{-2}. (UK)

39917 IMPROVED PARAMETERS FOR THE DIFFUSION-TRANSPORT APPROXIMATION. Calame, G. P. (U. S. Naval Academy, Annapolis, Md.). J. Nucl. Energy, 22: 497-503(Aug. 1968).

Alternate sets of parameters for use in Pomraning's diffusion–transport approximation are obtained by requiring that the use of the method yields good representations of flux transients between media and near sources. Numerical comparisons indicate that use of the new parameters gives results which are significantly more accurate than those obtained with the use of the parameters originally proposed. (auth) (UK)

39918 HIGH-RESOLUTION MONOCHROMATIZATION OF NEUTRONS BY MULTIPLE BRAGG REFLECTION IN HEXAGONAL CLOSE-PACKED CRYSTALS. Kottwitz, D. A. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Acta Crystallogr., Sect A, 25: 459-64(1969).

The conditions which give high-resolution monochromatization of neutrons by multiple Bragg reflection in hexagonal close-packed crystals have been studied theoretically. The role of reflections forbidden by special atomic positions has been clarified, and, contrary to a previous conclusion, it is found that these "forbidden" reflections may be useful for high-resolution purposes. Detailed calculations of the necessary crystal orientations have been carried out for beryllium, magnesium and zinc. On the basis of somewhat arbitrary criteria the calculations show that these crystals can reflect a total of approximately 200 wavelengths in the range 0.7 to 4.9 Å (neutron energy 0.003 to 0.17 eV). Several orientations have been found at which mosaic crystals (with a sacrifice of angular resolution) should produce beams that are both intense and highly monochromatic. (auth)

39919 ON THE NEUTRON TRANSPORT PROBLEMS BY THE DISCRETE-ORDINATES-NUMERICAL INTEGRATION METHOD. Takeuchi, Kiyoshi; Kataoka, Iwao (Ship Research Inst., Tokyo). Senpaku Gijutsu Kenkyujo, 6: No. 2, 33-47(Mar. 1969). (In Japanese).

A method, MENE, was developed for calculation of neutron transport problems in shields. This method applies the Discrete-Ordinates-Numerical Integration procedure to solve the steady

state energy-dependent Boltzmann transport equation in slab geometry. Anisotropic treatment for elastic scattering and isotropic treatment for inelastic scattering are taken into account in the neutron slowing down calculation. Neutron spectra and angular distributions in shields and/or behind them will be obtained as a result of the calculation. The numerical treatment of the equation and some calculations of neutron penetration spectra for various shielding materials are presented. Comparisons with other calculations and reliable experiments assure the method as an accurate procedure for neutron transport calculation in shields. (auth)

39920 BOREHOLE NEUTRON TUBE GENERATOR. Chrusciel, E.; Dabek, T.; Korbel, K.; Massalski, M. J.; Studnicki, J. (Inst. of Nuclear Techniques, Krakow). Isotopenpraxis, 5: 136-42(Apr. 1969).

A tube generator of fast neutrons (14.1 MeV) is discussed with neutron output of $2 \cdot 10^7$ n/s working in pulsed operation with the frequency of 400 Hz and with the pulse width of 100 μs. The accelerating voltage is 90 kV. The generator has been constructed in the form of a geophysical probe used for oil prospecting by means of n–γ logging. The time dependence of gamma ray intensity is measured by means of a four channel analyzer together with a photorecorder. The accuracy is sufficient owing to simultaneous monitoring of the fast-neutron flux. Maximum operation temperature of the prototype is 80°C. (auth)

39921 P_1 TOTAL SCATTERING PROBABILITY FOR LOW-ENERGY NEUTRON SCATTERING BY A MONATOMIC GAS. Pappano, A. W.; Blackshaw, G. L.; Squire, W. (West Virginia Univ., Morgantown). J. Nucl. Energy, 22: 453-64(Aug. 1968).

The P_1-moment of the total scattering probability is developed as a single integral expression over v_r, the relative neutron–nuclear speed, for low-energy elastic neutron scattering by the nuclei of a monoatomic gas. By employing the Brown and St. John $\sigma_s(v_r)$ representation for deuterium in D_2O, the P_1-moment and its corresponding P_0-moment are used to formulate and numerically evaluate an average thermal diffusion coefficient for heavy water at room temperature. The calculated value of $\overline{D}_{D_2O} = 0.804$ cm is approximately 5% lower than experimentally obtained results. It is expected that the derived P_1 formulations will be useful in analyzing those space-dependent neutron thermalization problems in which the free gas elastic scattering model can be employed. (auth) (UK)

39922 MULTIGROUP NEUTRON TRANSPORT THEORY IN PLANE GEOMETRY. McCrosson, Frank Joseph Jr. Blacksburg, Va., Virginia Polytechnic Inst., 1968. 141p.

Thesis.

An exact analytical procedure is presented for solving multigroup neutron transport problems in plane geometry. The method consists of analyzing a system of singular integral equations which is derived for the neutron distribution. Included in these singular integral equations are arbitrary inhomogeneous terms which depend only on the angle variable. Once these arbitrary functions are determined, the neutron distribution can be obtained from the singular integral equations by standard methods. To illustrate the procedure, the inhomogeneous terms associated with the infinite medium Green's function are determined. The Milne and critical problems are also considered. Here the inhomogeneous terms are expressed in terms of the emerging distribution at the boundary and the emerging distribution is given by a system of coupled Fredholm integral equations. The relationship between this method and Case's eigenfunction method is investigated. This leads to an alternate procedure for determining the expansion coefficients in Case's method. (Disser. Abstr.)

39923 POINT SOURCE GREEN'S FUNCTIONS FOR MONO-ENERGETIC NEUTRAL-PARTICLE TRANSPORT. Meyer, James Frederick. University Park, Pa., Pennsylvania State Univ., 1968. 106p.

Thesis.

Expressions for several point source Green's functions are developed which mathematically describe monoenergetic, neutral particle transport in uniform, unbounded media with particle absorption and azimuthally symmetric scattering. Specifically, for media characterized by finite-degree polar-direction-cosine scattering anisotropy, the following Green's functions are found: G1, the scalar flux resulting from a point source with finite degree angular anisotropy. G2, the scalar flux resulting from a monodirectional, point source. A reciprocity theorem of transport theory implies proportionality between this scalar flux and the vector flux resulting from an isotropic, point source in the same medium. G3, the vector flux resulting from a monodirectional, point source. Clearly, these Green's functions are interdependent, e.g., G1 is an angle-moment of G2 which is an angle moment of G3. Expressions for G1 and G2 are developed in addition to G3 because of the relative mathematical simplicity of the direct angle-moment derivation. Two lines of development are followed. The elementary features of both methods have been previously developed. They are: M1, the integral transport method of Davison. M2, the plane source superposition technique of Fano, Berger, and Spencer. In particular, M1 is employed, with extension to anisotropic scattering and anisotropic sources, in the development of G1 and G2, while M2 is employed, with explicit formulation of the relevant plane symmetry functions, in the derivation of G2 and G3. The principal advantage of M1 is in the various intermediate relations that are developed. These are helpful in following the derivation and in the development of physical inferences (e.g., the asymptotic behavior described in this work). Certainly, the principal advantage of M2 is in the development of G3 which is the basic Green's function. This technique, although mathematically straight-forward, is very formal and lacks the interpretative features of M1. Some limit properties of the Green's functions are considered with attention given to the implied physical aspects of neutral particle transport. For example, an expression is found which describes the extent to which a point source angular distribution is included in the asymptotic location dependence of the scalar flux on a sphere about the source. The study of the asymptotic behavior of the particle flux is but one application of the Green's functions developed in this work. These functions are the basic relations for attempting analyses of various physical problems of interest. (Disser. Abstr.)

39924 NEUTRON MODERATOR ASSEMBLIES FOR PULSED THERMAL NEUTRON TIME-OF-FLIGHT EXPERIMENTS. Day, D. H.; Sinclair, R. N. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 72: 237-53(1969).

Time-of-flight experiments using pulsed sources of fast neutrons (either pulsed fast reactors or linacs with suitable targets) require moderators to give thermal neutron pulses. The design of suitable moderators involves a compromise between maximum neutron intensity and good time resolution. The optimum moderator assembly for a particular experiment will depend on the neutron wavelength range of interest, the time and spatial resolutions required, etc. The measurement of neutron yields and pulse shapes for plane polythene slabs are described. Work has also been done on the use of homogeneous and heterogeneous poisoning to try to increase the neutron intensity while retaining a short duration pulse. The consequences of time focussing by using angled moderators have also been studied. Some comments are included on the theory and use of figures of merit for moderators, and the optimum geometries are discussed for three major classes of experiments. (auth)

Nuclear Properties and Reactions, $A \leq 5$

Refer also to abstracts 39666, 39856, and 40142.

39925 (LA-4191) POLARIZATION EFFECTS IN DEUTERON–ALPHA ELASTIC SCATTERING AND IN THE ^{3}He(d,p)^{4}He REACTION. Starkovich, Victor S. (Los Alamos Scientific Lab., N. Mex.). Feb. 1969. Contract W-7405-eng-36. 108p. Dep. CFSTI.

Azimuthal asymmetries produced in deuteron–alpha double scattering were measured at 9.0, 11.0, 11.5, and 14 MeV for a range of second-scattering angles. It was demonstrated that d–α elastic scattering can be used to produce a deuteron beam with useful vector polarization at energies near 10 MeV. It was also shown that d–α scattering can provide a useful absolute calibration for the vector polarization of a beam of deuterons produced by a polarized-ion source. Left–right proton asymmetries for the ^{3}He(d,p)^{4}He reaction were measured using a polarized deuteron beam obtained from d–α elastic scattering. Measurements were made for deuteron energies of 10.0, 12.0, and 14.0 MeV, extending the range of similar measurements made at the University of Wisconsin. (auth)

39926 ANISOTROPIC D(d,n)^{3}He-REACTION YIELD IN COPPER SINGLE CRYSTALS. Fischer, H.; Sizmann, R.; Bell, F. (Univ., Munich). Z. Phys., 224: 135-43(1969). (In German).

A self-target of deuterium (0.5 atomic-% D) in a single copper crystal is produced by a 75-keV deuteron beam. The neutron yield from the D(d,n)^{3}He reaction shows a 30% increase compared with the yield in polycrystalline copper, if the crystal is oriented in ⟨110⟩ to the beam. This result is discussed in terms of the channelling behavior of the penetrating deuterons parallel to the 110 lattice rows. (auth)

39927 PHASE CONSPIRACY IN UNOCCUPIED HARTREE–FOCK ORBITALS. Bassichis, W. H.; Strayer, M. R. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 23: 30–4 (July 7, 1969).

Second-order energies and the probabilities of two-particle, two-hole components in the ground states of ^{4}He and ^{16}O, calculated using perturbation theory in Hartree–Fock bases, show that excitations to high-lying levels are more important than the shell model predicts. The importance of these excitations stems from the relative phases of the Hartree–Fock wave functions for unoccupied states, and this phase relation can be explained quite simply. (auth)

39928 180° ELECTRON SCATTERING FROM ^{3}He AND ^{4}He AT 56 MeV. Chertok, B. T. (American Univ., Washington, D. C.); Jones, E. C.; Bendel, W. L.; Fagg, L. W. Phys. Rev. Lett., 23: 34–7(July 7, 1969).

The nuclear magnetic structure of ^{3}He was investigated by 180° scattering of 56.6-MeV electrons. The first observation of the M1 continuum in ^{3}He from 6 to 20 MeV is reported. The M1 component of the breakup from ^{3}He(e,e′)d,p together with ^{3}He(e,e′)p,p,n was measured and is discussed in light of possible isovector and isoscalar meson-exchange currents in the tri-nucleon system. The elastic magnetic form factor of ^{3}He at $q = 0.561$ fm^{-1} is 0.80, giving a rms magnetic radius $a = 1.94 \pm 0.19$ fm. (auth)

39929 VARIATIONAL ANALYSIS OF THE TWO-BODY PROBLEM WITH HARMONIC-OSCILLATOR STATES. Yeh, William Wen (State Univ. of New York, Stony Brook). Rev. Mex. Fis., 18: 11–40(1969).

A variational analysis of the deuteron problem was performed with a trial wave function that is a linear combination of harmonic oscillator states of up to 10 quanta. The energy is computed as a function of the frequency of the harmonic oscillator for several Gaussian potentials for the deuteron proposed by Feenberg and for the Eikemeier–Hackenbroich potential which has a soft repulsive core. The variational analysis is compared with the exact result, i.e., the binding energy of the deuteron, for both potentials. The variation of the root-mean-square radius of the deuteron as function of the maximum number of quanta considered in the expansion is indicated. The main purpose is to establish bound and convergence rates for the approximation process, which could be used in problems involving more than two particles. (auth)

39930 DEUTERON CAPTURE BY DEUTERONS. Del Bianco, W.; Poutissou, J. M. (Univ. of Montreal). Phys. Lett., 29B: 299–300(May 26, 1969).

The D(d,γ)^{4}He differential cross section at $\theta = 130°$ has been measured over the deuteron energy range from $\frac{1}{4}$ to 10 MeV with a 12.7 cm by 15.2 cm NaI crystal enclosed in a Čerenkov anti-coincidence shield. The differential cross section increases from $d\sigma/d\omega = (6.9 \pm 3.1) \times 10^{-33}$ cm^2/sr to $(16.5 \pm 6.8) \times 10^{-33}$ cm^2/sr at 4 and 10 MeV, respectively. (auth)

39931 STUDY OF ^{3}He(d,d)^{3}He AND ^{3}He(d,p)^{4}He WITH VECTOR-POLARIZED DEUTERONS BETWEEN 4 AND 10 MeV. Plattner, G. R.; Keller, L. G. (Univ. of Wisconsin, Madison). Phys. Lett., 29B: 301–3(May 26, 1969).

Angular distributions of the vector analyzing power have been measured between 4 and 10 MeV for the processes ^{3}He(d,d)^{3}He and ^{3}He(d,p)^{4}He. (auth)

39932 DIFFERENTIAL CROSS SECTION AND POLARIZATION IN p–α SCATTERING AT 12, 14.2, AND 17.5 MeV. Garreta, D.; Sura, J.; Tarrats, A. (CEN, Saclay, France). Nucl. Phys., A132: 204–12(1969).

Angular distributions of the proton differential cross section and polarization in p–α scattering were measured in the angular range $\theta_{c.m.} = 25$ to 161° at $E_p = 12.04$, 14.23, and 17.45 MeV. Phase-shift analyses of most of the available p–α scattering data at these energies were performed. No ambiguity was found in the determination of the phase shifts with the restriction that no attempt was made to obtain solutions drastically different from results of potential-model calculations. Error bars on the splittings $\delta_l^+ - \delta_l^-$ are three times smaller than error bars on the individual δ_l values showing strong correlations between the values of the phase shifts δ_l^+ and δ_l^-. The results are in good qualitative agreement with the results of the analysis of p–α scattering in terms of scattering of a single particle by an optical potential. (auth)

39933 POLARIZATION IN p–^{3}He SCATTERING BETWEEN 10 AND 20 MeV. Tivol, William Frederic. Berkeley, Calif., Univ. of California, 1968. 91p.

Thesis.

Using the polarized beam facility of the 88-inch isochronous cyclotron at Berkeley, the polarization of protons in the elastic scattering of polarized protons on ^{3}He was investigated. Four pairs of detectors were arranged around a target gas cell to count protons. These consisted of phototubes on which were mounted CsI crystals ground to a thickness approximately 50% greater than the range calculated for the protons. The signals from the detectors were routed into two 400-channel pulse height analyzers thereby separating the elastic peak from inelastic background. Backgrounds were low enough to permit an unambiguous treatment of the spectra. A solenoid magnet was used to flip the protons' spins in order to cancel any geometric asymmetries. The target gas cell was operated at 60 psi with a window of 1.9 mil dural for the higher energies, and at 20 psi with a 1 mil dural window at lower energies. At one energy points were taken with both operating conditions. Polarization as a function of angle for approximately twenty points were obtained for each of five energies in the range from 10 to 20 MeV by measuring the right-left asymmetry in the differential cross-section. The results are similar to the polarization in p–α scattering which seems to indicate that spin–orbit effects are large. Phase-shift analysis of the data shows no apparent regularities; however, all indications are that much more data are needed to determine the phase shifts accurately. In particular, triple scattering experiments, which determine spin correlation parameters, are especially necessary. (Diss. Abstr.)

39934 ISOBARIC-SPIN-$\frac{1}{2}$ STATES AND INTERMEDIATE SYMMETRY STATES IN THREE-BODY NUCLEI. Ohmura, Takashi (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 41: 419–41(Feb. 1969).

The ground-state wave functions of ^{3}H and ^{3}He are constructed separately by explicitly taking account of small charge asymmetry of nuclear forces and the Coulomb force between two protons in the ^{3}He nucleus. Charge independence is assumed for the range parameters of the nuclear force but not for the depth parameters. It is found that: (1) The isospin $T = \frac{1}{2}$ admixture in ^{3}He owing to the Coulomb force alone is about 4×10^{-6} in probability. Small violation of charge independence hypothesis in actual nuclear forces (namely, the difference in n-p and p-p) induces the isospin admixture of about 5×10^{-6} in ^{3}H and 2×10^{-5} in ^{3}He if the charge symmetry is assumed. These values are not much dependent on the hard core radius and on exchange character of nuclear forces. (2) The calculated Coulomb energy of ^{3}He (assuming extended protons) suggests that the n-n potential will be stronger than the p-p nuclear potential in the singlet state though no more than 1% for which the isospin admixture in ^{3}H is about 10^{-6}. (3) The polar vector matrix element for the β-decay of ^{3}H is smaller than unity by only of the order of 10^{-4}. (4) The S′-state probability increases as the hard core radius increases so that a large difference between the charge form factor of ^{3}H and that of ^{3}He observed in electron scattering experiments is consistent with the hard core radius of 0.4 fm or larger. The conclusions are qualitatively correct even if any "realistic" nuclear force is used. (auth)

39935 THE REACTION ^{2}H(p,2p)n BETWEEN 5 AND 10 MeV. Jeremie, H.; Gray, T. (Univ. of Montreal). Nucl. Phys., A132: 571–80(1969).

The energy spectra of the two outgoing protons in the reaction ^{2}H(p,2p)n have been studied at various incident energies between 5 and 10 MeV. Enhancements in the cross sections due to final-state interactions and spectator poles have been observed. The study of the final-state interactions yields an n-p scattering length of 24 ± 1.2 fm which agrees with the value obtained directly from n-p scattering. (auth)

39936 CROSS SECTIONS FOR PROTON–DEUTERON SCATTERING FROM 1.0 TO 10.0 MeV. Kocher, D. C.; Clegg, T. B. (Univ. of Wisconsin, Madison). Nucl. Phys., A132: 455–67(1969).

Absolute differential cross sections for the scattering of protons by deuterium were measured at eight proton energies from 1.000 to 10.04 MeV for angles from 10.50 to 166.00° in the center-of-mass system. The median uncertainty of all measurements is ±0.6%. (auth)

39937 TOTAL CROSS SECTION MEASUREMENTS FOR ^{3}He(^{3}He,2p)^{4}He AT LOW ENERGIES. Dwarakanath, Mirmira Ramarao. Pasadena, Calif., California Inst. of Tech., 1969. 139p.

Thesis.

Precise measurements of the total reaction cross section for ^{3}He(^{3}He,2p)^{4}He were made in the range of center-of-mass energies between 1100 and 80 keV. A differentially pumped gas target modified to operate with a limited quantity of the target gas was employed to minimize the uncertainties in the primary energy and energy straggle. Beam integration inside the target gas was carried out by a calorimetric device which measures the total energy spent in a heat sink rather than the total charge in a Faraday cup.

Proton energy spectra were obtained using a counter telescope consisting of a gas proportional counter and a surface barrier detector and angular distributions of these protons have been measured at seven bombarding energies. Cross section factors, S(E), were calculated from the total cross sections and fitted to a linear function of energy over different ranges of energy. For E_{cm} < 500 keV $S(E_{cm}) = S_0 + S_1 E_{cm}$, where $S_0 = (5.0^{+0.5}_{-0.4})$ MeV – barns and $S_1 = (-1.8 \pm 0.5)$barns. (Disser. Abstr.)

39938 POLARIZATION OF ^{3}He ELASTICALLY SCATTERED FROM ^{4}He. Armstrong, D. D.; Catlin, L. L.; Keaton, P. W. Jr.; Veeser, L. R. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett., 23: 135-7(July 21, 1969).

The polarization of ^{3}He nuclei elastically scattered from ^{4}He was measured. Absolute polarization values were determined from three asymmetries measured at appropriate energies and angles using double-scattering techniques. A polarization angular distribution at 13-MeV ^{3}He energy indicates general agreement with previously reported phase shifts. (auth)

39939 INVESTIGATION ON THE NEUTRON-POLARIZATION IN ^{2}H/d,n/^{3}He. Prade, Harald (MTA Atommag Kutato Intezete, Debrecen, Hungary). ATOMKI (At. Kut. Intez.) Kozlem., 11: 1-7 (May 1969). (In Hungarian).

Polarization of neutrons from the ^{2}H/d,n/^{3}He reaction, at angles between 48° and 54° (lab.) as a function of the deuteron energy was measured at average deuteron energies of 92, 109, 137, 169 and 173 keV with a thick target. For 109, 137 and 169 keV deuteron energies the neutron polarization was calculated from measurements of the left-right asymmetry in scattering from carbon. At 92 and 173 keV the neutron polarization was determined from the measured angular distribution of helium recoil tracks in a Wilson cloud chamber. The polarization varies strongly between 92 and 173 keV deuteron energy. If taking into account the data measured at higher energies, the results unambiguously prove the existence of the minimum in the polarization for $E_d \sim 200$ keV. The present measurements support the Wills' phase shifts. (auth)

39940 OBTAINING OF MONOCHROMATIC GAMMA-QUANTUM BEAM IN ^{7}Li(pγ)^{8}Be REACTION. Kalinin, B. N.; Kotlyar, E. V.; Stukov, O. I.; Frolov, V. F. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 18-21(1969). (In Russian).

Production of monochromatic γ beams of 14.8- and 17.6-MeV energy is described. Data are given on the calibration of a single crystal total absorption γ spectrometer and energy calibration of electrostatic proton beam generators during resonance capture of protons by lithium target nuclei in the reaction ^{7}Li(p,γ)^{8}Be. The energy resolution of the scintillation spectrometer for the lines 17.6 and 14.8 MeV was 12.5 and 13.6%, respectively. The resonance energy of 441 keV protons was determined with the order of error ±0.44 keV. (R.V.J.)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 39307, 39614, 39651, 39927, 40012, 40109, 40110, 40112, 40113, 40132, 40138, 40141, 40153, 40160, and 40161.

39941 (NP-17890) ANNUAL REPORT FOR THE YEAR ENDING DECEMBER 1968. McMurray, W. R. (comp.) (Southern Universities Nuclear Inst., Faure (South Africa)). 37p. Dep.

ALUMINUM-25 — energy-level transitions from magnesium-24 (p,γ) reactions, (E)
ALUMINUM-26 — energy levels from (d,α) reactions, level widths for compound nucleus, (E)
ALUMINUM-27 — energy levels from (d,α) reactions, level widths for compound nucleus, (E)
ARGON-37 — energy levels from (d,α) reactions, level widths for compound nucleus, (E)
BORON-10 — deuteron reactions (d,n) with, DWBA analysis of, (E/T)
CALCIUM-40 — energy levels from potassium-39 (p,γ) reactions, widths for, (E)
CALCIUM-43 — energy levels from (d,α) reactions, level widths for compound nucleus, (E)
CALCIUM-48 — proton reactions (p,n) at 2 MeV, neutron time-of-flight spectra for, (E)
CARBON-13 — deuteron reactions (d,n) with, DWBA analysis of, (E/T)
CHLORINE-34 — energy levels from (d,α) reactions, level widths for compound nucleus, (E)
LITHIUM-7 — proton reactions (p,n) at 2.4 MeV, neutron time-of-flight spectra for, (E)
MAGNESIUM-25 — deuteron reactions (d,α) at 5 to 5.5 MeV, analysis using Hauser–Feshbach and fluctuation theory, (E/T)
PHOSPHORS — neutron pulse-height response in, anthracene direction-sensitive effects in
PHOSPHORUS-30 — energy levels from sulfur-32 (d,α) reactions, spin assignments for, (E)
SILICON-29 — energy levels from (d,α) reactions, level widths for compound nucleus, (E)
SODIUM-23 — energy levels from neon-22 (p,γ) reactions, widths for, (E)
SULFUR-32 — proton elastic and inelastic scattering at 2.8 to 5.5 MeV, cross sections for, (E)
— energy levels from proton inelastic scattering, spin-parity assignments and widths for, (E)
— deuteron reactions (d,α) at 5 to 5.5 MeV, analysis using Hauser–Feshbach and fluctuation theory, (E/T)
SULFUR-33 — energy levels from chlorine-35 (d,α) reactions, spin assignments for, (E)
THORIUM-232 — energy levels from neutron inelastic scattering, (E)
URANIUM-238 — energy levels from neutron inelastic scattering, (E) (J.W.R.)

39942 ROOT MEAN SQUARE CHARGE RADII OF ^{12}C, ^{14}N, AND ^{16}O. Bentz, Hans Alfred (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch., 24a: 858-9(May 1969).

From elastic electron scattering between 30 and 60 MeV, the following essentially model independent rms charge radii (fm) were deduced: 2.395 ± 0.028 (^{12}C); 2.492 ± 0.033 (^{14}N); 2.666 ± 0.033 (^{16}O). An improved value for ^{9}Be is (2.43 ± 0.08) fm. (auth)

39943 A DWBA CALCULATION FOR THE ANGULAR DISTRIBUTION IN THE ^{12}C(n,α)^{9}Be REACTION AT 14 MeV. Chatterjee, M. L.; De, T. (Saha Inst. of Nuclear Physics, Calcutta). Indian J. Phys., 42: 486-95(Aug. 1968).

The angular distribution for the ^{12}C(n,α) reaction leading to the ground state of ^{9}Be was studied in this laboratory previously (1964). Now a DWBA calculation was performed with pick-up and knock-on modes to fit the angular distribution. For simplicity zero-range interactions were considered. Fits were calculated by varying the well depths of the optical potentials for the neutron and the alpha. The effect of introducing cut-off in the lower range of the radial integral was also examined. For the calculation of the bound-state wave functions a square-well potential was assumed. A reasonably good fit to the experimental distribution was obtained in the forward hemisphere, but the backward peak could not be reproduced. (auth)

39944 MEASUREMENTS OF THE LIFETIMES OF THE 1740, 2154, AND 3585 keV STATES OF ^{10}B. Jackson, Kenneth Peter. Toronto, Univ. of Toronto, 1967.

Thesis.

The mean lifetimes of the 1740 keV, the 2154 keV, and the 3585 keV states of ^{10}B were estimated by the Doppler shift attenuation method. The ^{11}B(^{3}He,α)^{10}B reaction was used to populate the levels. ^{10}B nuclei recoiling with a known initial velocity in two different directions with respect to the incident beam were selected by observing, in two charged particle detectors, the alpha particles emitted in the reaction. Two separate spectra of those gamma rays emitted in the decay of the ^{10}B nuclei recoiling in the two directions were recorded concurrently using a single NaI(Tl) detector. The Doppler shifts in the energies of the emitted gamma rays were determined from these two spectra. For each transition observed, the attenuation of the Doppler shift, resulting from the slowing down of the recoil nuclei in the target used, was derived from the measured shift and the value of the full shift calculated on the basis of the known reaction kinematics. The shift observed in the energy of the (1740 keV → 719 keV) transition was consistent with no attenuation of the Doppler shift, and the life-time of the 1740 keV level was estimated to be $\leq 0.22 \times 10^{-13}$ sec. From the values of the Doppler shift attenuation observed in both the (2154 keV → 1740 keV) and the (2154 keV → 719 keV) transitions, a mean lifetime of $(20 \pm 2.5) \times 10^{-13}$ sec was obtained for the 2154 keV level. The lifetime of the 3585 keV level was estimated to be $(1.52 \pm 0.21) \times 10^{-13}$ sec the basis of the Doppler shift observed in the (3585 keV → 719 keV) transition. From observations used to assess the possible influence of (α–γ) angular correlations on the lifetime measurements, the following limits were placed on the value of δ, the E2/M1 amplitude ratio for the (2154 keV → 719 keV) transition: $(-5 \leq \delta \leq -0.2)$. The estimates of the absolute radiative widths that can be derived from these lifetime measurements and from the known properties of the transitions from the three levels are compared with theoretical predictions based on two different formulations of the independent particle model. (Diss. Abstr.)

39945 ON CORRECTIONS OF THE ORDER αZ TO THE μ^- CAPTURE BY ^{12}C NUCLEUS. Oziewicz, Z.; Pikul'ski, A. (Joint

Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 1046-9(May 1969). (In Russian).

Results are presented of calculations of probability of the partial transition $^{12}C \rightarrow {}^{12}B$ to the ground state of the ^{12}B nucleus with all the correction of the order αZ in the interaction Hamiltonian included. It is shown that at $C_p = 8C_A$ the corrections contribute -10% to the transition probability and $+2\%$ to the Morita–Fujii result. (auth)

39946 REACTION $^{11}B(\alpha,p_0)^{14}C$. Spasskii, A. V.; Tarov, K. G.; Teplov, I. B.; Fateeva, L. N. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 9: 936-9(May 1969). (In Russian).

Differential cross sections of the reaction $^{11}B(\alpha,p_0)^{14}C$ measured in the α-particle energy region from 10 to 25 MeV are presented. Seven angular distributions and the excitation functions for three values of the proton emission angle ($\theta_{lab} = 30°$, 90°, 158°) were measured. (auth)

39947 STUDY OF 660 MeV PROTON INTERACTION WITH OXYGEN NUCLEI. Dudkin, V. E.; Kuz'min, V. N.; Smirennyi, L. N.; Shimanskaya, N. S.; Yakovlev, R. M. Yadern. Fiz., 9: 925-9(May 1969). (In Russian).

Production cross sections and energy and angular distributions of one-charge ($0 \leq E \leq 15$ MeV) and two-charge ($0 \leq E \leq 50$ MeV) particles from oxygen nuclei are obtained. Experimental results are analyzed from the standpoint of single inelastic collisions of bombarding protons with substructure of the nucleus. (auth)

39948 EXCITATION FUNCTIONS OF THE REACTIONS (γ,p) AND (γ,d) ON ^{12}C AT THE PHOTON ENERGY 400 TO 1400 MeV. Antuf'ev, Yu, P.; Agranovich, V. L.; Ganenko, V. B.; Kuz'menko, V. S.; Miroshnichenko, I. I.; Sorokin, P. V.; Sanin, V. M. (Physical-Technical Inst., Kiev). Yadern. Fiz., 9: 921-4(May 1969). (In Russian).

Excitation functions for protons with energy 97 and 340 MeV and for deuterons with energy 194 MeV emitted from the ^{12}C nucleus at the angle 30° in lab. system were measured in the reaction (γ,p) and (γ,d) in the photon energy region 400 to 1400 MeV. The kind of the energy dependence of the proton and deuteron yield corresponds to the mechanism of meson photoproduction on quasi-free nucleons and two-nucleon associations. The calculations made in the momentum approximation for the photoprotons with the energy 340 MeV are in good agreement with corresponding experimental data. (auth)

39949 PHOTOABSORPTION CROSS SECTION BY ^9Be NUCLEI IN THE REGION OF GIANT DIPOLE RESONANCE. Dolbilkin, B. S.; Isakov, A. I.; Korin, V. I.; Lazareva, L. E.; Lin'kova, N. V.; Nikolaev, F. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 9: 914-20(May 1969). (In Russian).

Nuclear cross section of γ quanta absorption in the region of the giant dipole resonance (10 to 30 MeV) was measured. The experiment was performed using the 250-MeV bremsstrahlung beam of synchrotron measuring the attenuation coefficient of a collimated γ beam in the beryllium absorber. Photons were detected by a nine-channel magnetic pairs spectrometer with the resolution ~1%. The cross section has complex resonance structure. Within 10 to 29 MeV the cross section is 156 ± 15 mbn·MeV. The results are compared with those of other experiments and with the calculations according to the shell model. (auth)

39950 MEASUREMENT OF LEVEL-EXCITATION CROSS SECTIONS FOR THE NUCLEI ^{16}O, ^{27}Al, ^{52}Cr, AND $^{64,66,68}Zn$ INDUCED BY 14.6-MeV NEUTRONS. Burymov, E. M. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 9: 933-5(May 1969). (In Russian).

Cross sections were obtained for excitation of some levels in ^{16}O, ^{27}Al, ^{52}Cr, and $^{64,66,68}Zn$ induced by neutrons with energy 14.6 MeV. (auth)

39951 PARITY-FORBIDDEN ALPHA DECAY OF SOME ^{16}O LEVELS. Gari, M.; Kuemmel, H. (Max-Planck-Institut fuer Chemie, Mainz). Phys. Rev. Lett., 23: 26-8(July 7, 1969).

The theory of the parity-nonconserving alpha decays from the 2^- (8.88 MeV), 0^- (10.937 MeV), and 3^+ (11.05 MeV) ^{16}O levels is developed. Using the weak nucleon–nucleon interaction of Blin-Stoyle and Herczeg and known ^{16}O wave functions modified by short-range correlations via the Bethe–Goldstone equation, the irregular alpha widths were related to known regular widths. The influence by the hard core of the strong interaction was studied. (auth)

39952 SHORT-RANGE CORRELATIONS AND ELASTIC ELECTRON SCATTERING. Tuan, S. T. (Inst. for Theoretical Physics, Frankfurt am Main); Wright, L. E.; Huber, M. G. Phys. Rev. Lett., 23: 174-5(July 28, 1969).

The effects were of the short-range correlations on the form factor of elastic electron scattering were calculated in the Born approximation for ^{16}O as an example. It turns out that in the high-momentum-transfer region it is essential to take into account the modifications of the nucleonic wave function for small internucleonic distances; the results indicate that from precise measurements details about the momentum exchange between bound nucleons can be deduced. (auth)

39953 MODIFIED-McINTYRE-MODEL ANALYSIS OF HEAVY-ION ELASTIC SCATTERING AT MEDIUM ENERGIES. Helb, H.-D.; Voit, H.; Ischenko, G.; Reichardt, W. (Univ., Erlangen-Nuernberg, Ger.). Phys. Rev. Lett., 23: 176-8(July 28, 1969).

The A_l function of the McIntyre model was modified to fit the measured differential cross sections of the elastic scattering ^{14}N on ^{12}C at $E_{lab} = 22.5$ MeV, which shows extensive structure for large C–M angles. The modified A_l is a Woods–Saxon type function with a sharp drop for a certain l value. This drop simulates a great number of surface reactions, which diminish the elastic channel in the case of grazing collisions. (auth)

39954 THREE-BODY PARTIAL-WAVE ANALYSIS FOR THE FINAL-STATE SCATTERING OF (π^-,NN) FROM ^{12}C AND ^{16}O. Weber, H. J. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett., 23: 178-81(July 28, 1969).

A nonrelativistic three-body treatment in the Born approximation is used for the final-state nucleon–nucleon scattering in the field of the residual nucleus, following the absorption of a bound pion in ^{12}C and ^{16}O. It is shown that the NN energy distributions represent a very sensitive probe of the nuclear two-body force and of the stronger optical potential which serves to describe multiple-scattering effects. (auth)

39955 SPRAVOCHNYE TABLITSY DLYA NEITRONO-AKTIVATSIONNOGO ANALIZA. (Reference Tables for Neutron-Activation Analysis). Mednis, I. V. Riga, Izdatel'stvo Zinatne, 1969. 207p.

Published data (up to 1967) on cross sections of nuclear activation reactions (n,γ) by thermal neutrons and (n,2n), (n,p), and (n,α) for 14- to 15-MeV neutrons are covered. The tables include the physical constants and basic isotope characteristics. The data are distributed starting with the initial stable isotope, reactions producing radioactive isotopes with the isotopes given in the order of their atomic number, half-life period, and γ emission energy. 330 references are included. (R.V.J.)

39956 THE (γ,p) REACTION IN SOME LIGHT AND MEDIUM WEIGHT NUCLEI. Hofmann, W.; Kosiek, R.; Kraft, G.; Mundhenke, R. (Univ., Heidelberg). Z. Phys., 225: 303-26(1969). (In German).

Photoproton spectra were obtained from gaseous ^{16}O, ^{20}Ne, ^{22}Ne, ^{36}Ar, ^{40}Ar, ^{84}Kr, Kr, and Xe and from foils of ^{23}Na and K irradiated with bremsstrahlung from 24 to 32.5 MeV endpoint energy. The charged particles were detected at 90° to the γ beam by a Cs(Tl) spectrometer with pulse-shape discrimination. Yields and lower limits for the integrated cross sections are given. For argon and the heavier nuclei, the results are compared with statistical-model calculations. (auth)

39957 A STUDY OF THE $Li(p,\alpha)\alpha$ REACTION AS A STUDENT EXERCISE. Duggan, J. L. (Oak Ridge Associated Universities, Inc., Tenn.). J. Nucl. Energy, 22: 611-19(Oct. 1968).

Details are given of a charged-particle experiment that can be performed in the nuclear engineering curriculum by schools that have small Cockcroft–Walton or Van de Graaff accelerators. The necessary modifications to the accelerator and the procedure for measurements of the $^7Li(p,\alpha)\alpha$ reaction are described. (UK)

39958 APPLICATION OF THE REACTION (d,α) ON ^{14}N TO THE STUDY OF THE GROUND-STATE AND THE FIRST EXCITED LEVELS OF ^{12}C. Joseph, Jacques; Nahabetian, Robert; El Baz, Edgard; Lafoucriere, Joseph (Univ., Lyon). Compt. Rend., Ser. B, 268: 1039-41(Apr. 14, 1969). (In French).

The reaction $^{14}N(d,\alpha)^{12}C$ was analyzed by the distorted-waves method to determine the amplitude of the configuration $(p_{\frac{3}{2}})^6(p_{\frac{1}{2}})^2$ for the ground state of ^{12}C. This amplitude is determined from the agreement of the cross sections for the ground state and first-excited 2^+ level at 4.43 MeV. (tr-auth)

39959 EVIDENCE FOR A 0^+ STATE IN ^{16}O AT 14.0 MeV. Stroetzel, M.; Goldmann, A. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 29B: 306-7(May 26, 1969).

A new 0^+ state has been found in ^{16}O at 14.00 ± 0.05 MeV by inelastic electron scattering. The monopole matrix element is 3.3 ± 0.7 fm^2, the transition radius 6.5 ± 1.6 fm, and the total width 170 ± 50 keV. (auth)

39960 WIDTH OF THE 4+ (11.4 MeV) LEVEL OF ^8Be FROM $^7Li(d,n)2\alpha$. Hofmann, G.; Kamke, D. (Ruhr Univ., Bochum, Ger.). Z. Phys., 224: 446-60(1969). (In German).

With the reaction $^7Li + d \rightarrow n + {}^8Be \rightarrow n + 2\alpha$ the location and

width of the ^{9}Be(4,+) level is redetermined. While the location at 11.4 ± 0.05 MeV is found in agreement with known values, the width is found to be only Γ = 2.8 ± 0.2 MeV, disagreeing with data from $\alpha-\alpha$ scattering but being close to a recent determination from the reaction ^{10}B(d,α)^{8}Be (Γ = 2.6 MeV). No indication for participation of an excited state of ^{5}He in the simultaneously possible reaction via ^{5}He is found. (auth)

39961 2^+ STATES OF ^{8}Be. Barker, F. C. (Australian National Univ., Canberra). Aust. J. Phys., 22: 293-316(June 1969).

Analysis by many-level R-matrix theory of the d-wave $\alpha-\alpha$ scattering phase shift suggests the existence of broad 2^+ excited states of ^{8}Be, but their properties depend sensitively on the assumed channel radius a_2. A simultaneous fit to the ^{7}Be(p,d)^{8}Be deuteron spectrum near the 2.9-MeV peak requires $a_2 \approx 7.1$ fm, while a simultaneous fit to the α-particle spectra following ^{8}Li and ^{8}B β decays requires $a_2 \approx 6.7$ fm. For the best overall fit with $a_2 = 6.75$ fm, the first 2^+ excited state is at 2.84-MeV excitation energy with a width at half maximum of 1.30 MeV. It is shown that data from other reactions which appeared to give much larger widths for this level can be fitted using the same R-matrix parameters. A second 2^+ excited state is obtained at about 9 MeV with a width of about 10 MeV. Properties of the narrow 2^+ states at 16.6 and 16.9 MeV are also discussed. (Australia)

39962 THE ELASTIC AND INELASTIC SCATTERING OF PROTONS FROM ^{10}B BETWEEN 5 AND 16 MeV. Watson, Bruce Allan. Bloomington, Ind., Indiana Univ., 1968. 194p.

Thesis.

The elastic and inelastic scattering of protons from ^{10}B was investigated over the energy range 5.0 to 16.5 MeV. Angular distributions for inelastically scattered protons leading to the 0.717-, and 1.74-, 2.15-, 3.59-, 4.77-, and 6.04-MeV states in ^{10}B were measured in 300-keV steps between 5 and 12 MeV and in 500-keV steps from 12 to 16 MeV. The angular distributions consisted of measurements at 5° intervals from 15 to 165°. Yield curves for protons feeding these states were obtained in 100-keV steps from 5 to 16 MeV at the five angles 65, 85, 115, 135, and 165°. The differential cross sections for elastically scattered protons, measured at several energies between 5 and 13 MeV, show diffraction-type structure typical of direct interactions. The main feature of the yield curves is a broad resonance centered at about 7.5 MeV bombarding energy with a width the order of 4 MeV. Fine structure is superimposed on this broad resonance. The cross section for formation of the 6.04-MeV state is a factor of five larger than that for any of the lower-lying levels. The differential cross sections for the elastically scattered protons were analyzed in terms of the optical model. Since a set of optical-model parameters must give a reasonable description of nucleon scattering from several nuclei for a wide range of energies if it is to be meaningful, published differential cross sections and polarizations of protons elastically scattered from other 1p-shell nuclei for bombarding energies between 10 and 50 MeV were incorporated into the analysis. The effects on the parameters due to the nonlocality of the potential were investigated. Using the formalism of Perey and Buck, it was found that, in the case of light nuclei, the energy dependence of the radius parameter of the real central potential is large enough to be observed for the energy range covered by this data. (Diss. Abstr.)

39963 DISTORTED-WAVE ANALYSIS OF (d,^{3}He) REACTIONS AT E_d = 82 MeV. Doubre, H.; Royer, D.; Arditi, M.; Bimbot, L.; Frascaria, N.; Garron, J. O.; Riou, M. (Institut de Physique Nucleaire. Orsay, France). Phys. Lett., 29B: 355-8(June 9, 1969).

The (d,^{3}He) reaction was studied for targets of ^{16}O, ^{40}Ca, and ^{58}Ni to test DWBA predictions at high incident deuteron energy. Spectroscopic factors are obtained in local, zero-range, and in non-local, finite-range approximations. (auth)

39964 MULTILEVEL ANALYSIS OF THE p-WAVE ^{12}C$-\alpha$ ELASTIC SCATTERING PHASE SHIFT BETWEEN 9.16 AND 12.11 MeV. Clark, G. J. (Australian National Univ., Canberra). Aust. J. Phys., 22: 289-92(Apr. 1969).

A three-level analysis for improved fitting of p-wave phase shifts in ^{12}C$-\alpha$ elastic scattering is outlined. Only the one-channel case of elastic scattering was considered, and a nonlinear least-squares fitting program was used. A background level was included, and acceptable fits ($x^2 \leq 1$) were obtained over the range 40 to 80 MeV. A value of 0.53 was assigned to the α-particle reduced width for the 7.116-MeV 1^- level in ^{16}O, but this has an estimated possible error of 50%. The value assigned to the dimensionless reduced width, with the limits of $0.7 < x^2 < 1.1$, was $0.71^{+0.1}_{-0.2}$. (Australia)

39965 THE ^{18}O(α,γ)^{22}Ne REACTION. Adams, A.; Shapiro, M. H.; Denny, W. M.; Adelberger, E. G.; Barnes, C. A. (California Inst. of Tech., Pasadena). Nucl. Phys., A131: 430-4 (1969).

With time-of-flight techniques to reduce fast-neutron background, an excitation function for the ^{18}O(α,γ)^{22}Ne reaction was measured over the energy range E_α = 2.15 to 3.70 MeV. The energy dependence of the reaction cross section is compared with the predictions of the nuclear optical model. (auth)

39966 STATES OF ^{9}Be FROM THE BETA-DECAY OF ^{9}Li. Macefield, B. E. F.; Wakefield, B.; Wilkinson, D. H. (Nuclear Physics Lab., Oxford). Nucl. Phys., A131: 250-60(1969).

The neutron spectrum following the beta decay of ^{9}Li is studied with a time-of-flight spectrometer. A neutron group of 0.68 MeV is seen corresponding to the decay to the ground state of ^{8}Be of the 2.43-MeV state of ^{9}Be; a group of energy 1.2 ± 0.1 MeV and width 1.0 ± 0.2 MeV corresponds to a level in ^{9}Be at 3.0 ± 0.1 MeV. It is suggested that this is the "missing" $J^\pi = 1/2^-$ level predicted by the independent-particle model. The log ft value (5.2 ± 0.2) for the ^{9}Li β decay to this state and its absolute width agree with the expectation of the model. ^{9}Be(e,e′)^{9}Be data are consistent with such a state and provide a measure of its M1 radiative width to the ground state in adequate agreement with the model. (auth)

39967 CHEW–FRAUTSCHI PLOT FOR NUCLEON–NUCLEUS SCATTERING. Iwao, Syurei (Kanazawa Univ., Japan). Progr. Theor. Phys. (Kyoto), 41: 560-1(Feb. 1969).

Spin 3/2 and 7/2 as well as 1/2 and 5/2 states were included in the Chew–Frautschi plot for the proton or neutron trajectories of ^{15}N states from ^{14}C(p,p) or ^{14}N(n,n) reactions. (J.W.R.)

39968 THE ELASTIC SCATTERING OF PROTONS BY ^{16}O IN THE ENERGY RANGE 16 TO 30 MeV. Karban, O. (Univ. of Birmingham, Eng.); Greaves, P. D.; Hnizdo, V.; Lowe, J.; Berovic, N.; Wojciechowski, H.; Greenlees, G. W. Nucl. Phys., A132: 548-60(1969).

For proton-oxygen elastic scattering measurements are presented of differential cross sections at eight energies between 19.8 and 30.5 MeV, polarization at 19.8, 20.4, 20.8, 21.4, 22.1 and 30.3 MeV and the integrated excitation function at backward angles from 16.0 to 30.6 MeV. The latter shows anomalies at E_p = 17.6, 20.4, 21.8, 23.3, 26.7 and 28.4 MeV. The data are analyzed in terms of optical-model plus compound-nucleus-scattering amplitudes. A fit to experimental results is presented assuming contributions from four resonances at energies 17.6, 20.4, 26.7 and 28.4 MeV with J^π assignment $5/2^-$, $3/2^-(3/2^+)$, $3/2^-$ and $5/2^-$, respectively. (auth)

39969 COMPARISON OF THE REACTIONS (α,^{3}He) AND (α,t) ON SOME NUCLEI N = Z. Gaillard, P.; Bouche, R.; Feuvrais, L.; Gaillard, M.; Guichard, A.; Gusakow, M.; Leonhardt, J. L.; Pizzi, J. R. (Univ., Lyon). Nucl. Phys., A131: 353-77(1969). (In French).

Differential cross sections were measured for the ground-state groups of the (α,^{3}He) and (α,t) reactions on the N = Z nuclei ^{10}B, ^{12}C, ^{14}N, ^{32}S and ^{40}Ca and for elastic scattering of 56 MeV alpha particles by the same targets. The yield of ^{3}He is larger than the yield of tritons. A DWBA analysis has been performed assuming a stripping reaction mechanism. The predicted ratios of (α,^{3}He) and (α,t) cross sections are compared with the experimental values. The influence of various terms in the DWBA calculations is studied. (auth)

39970 INELASTIC SCATTERING OF ELECTRONS ON CARBON. Gul'karov, I. S.; Afanas'ev, N. G.; Khomich, A. A.; Afanas'ev, V. D.; Khvastunov, V. M.; Savitskii, G. A.; Shevchenko, N. G. (Physical-Technical Inst., Kharkov). Yadern. Fiz., 9: 1138-51(June 1969). (In Russian).

Form factor of the level with the excitation energy 16.1 MeV, eight spectra of giant dipole resonance of ^{12}C nucleus (θ = 20–80°) as well as the spectrum of quasielastic scattering (E_0 = 199.5 MeV, θ = 80°) are measured by means of the electron inelastic scattering with the initial energy 115 and 200 MeV. Reduced probabilities of transition, transition radii and oscillation parameters of the ^{12}C nucleus are determined from the data on the excitation of the 16.1-MeV level and of giant resonance. The experimental data obtained are compared with predictions of some nuclear models. (auth)

39971 INVESTIGATION OF SPALLATION OF THE NUCLEI F, Mg, Al, Si WITH FRAGMENTS, INDUCED BY HIGH-ENERGY PROTONS. Fedoseev, G. A.; Moskaleva, L. P.; Shcherbovskii, B. Ya. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Yadern. Fiz., 9: 1155-8(June 1969). (In Russian).

Data on energy distributions of heavy fragments ^{19}F, ^{22}Na, ^{24}Na produced by high-energy protons, are obtained by means of the thick-absorber method. Analysing the anisotropy coefficients and the maximal ranges of heavy fragments some conclusions

are deduced about the mechanism of the fragmentation process. (auth)

39972 $^{12}C[^3He, ^8Be(g.s.)]^8Be(g.s.)$ REACTION. Jayaraman, Killugudi Sambamoorthy. College Park, Md., Univ. of Maryland, 1968. 83p.

Thesis.

The reaction $^{12}C[^3He,^8Be(g.s.)]^8Be(g.s.)$ was investigated in the energy region of 2.0 to 6 MeV. The yield at 40° (lab.) shows a resonance 600-keV wide at an excitation of 27.4 MeV in ^{15}O ($E_{^3He}$ = 5.75 MeV). The angular distribution at the resonance is analyzed in the framework of the compound nucleus model. Calculations were also performed using the optical model code ABACUS to search for the energies at which single particle resonances might occur in the exit channel of the above reaction using a rather shallow potential to describe the $^8Be-^8Be$ interaction. The differential cross sections were also studied at 3.3 and 5.0 MeV of ^3He. At these energies where the cross section is less energy dependent the angular distributions were analyzed in the framework of a direct interaction theory using the code JULIE. The model for the assumed interaction considers that a five nucleon cluster (^5He) is transferred from ^{13}C to ^3He. The analysis is performed in the so called zero-range approximation. The total cross section for the $^{13}C[^3He,^8Be(g.s.)]^8Be(g.s.)$ reaction is surprisingly large when compared with the $^{13}C-(^3He,\alpha)^{12}C$ reaction proceeding to any specific excited state of ^{12}C. Hence, even though the process which is responsible for the reaction must be relatively complex, it appears to have a high probability of occurrence compared to the simpler processes which might be responsible for the $(^3He,\alpha)$ reactions. (Disser. Abstr.)

39973 EXCITED STATES OF ^{19}O STUDIED BY THE REACTION $^{18}O(d,p)^{19}O$. Fintz, P.; Hibou, F.; Rastegar, B.; Gallmann, A. (Institut de Recherches Nucleaires, Strasbourg). Nucl. Phys., A132: 265-75(1969). (In French).

A Buechner-type magnetic spectrograph has been used to study the $^{18}O(d,p)^{19}O$ reaction between 20 and 130° with respect to the incident deuteron beam at E_d = 5 MeV. Proton groups corresponding to previously reported levels, up to 4.118 MeV excitation energy in ^{19}O, have been observed and the energies of nine excited states are determined. No evidence is found for the previously reported levels at 0.348, 1.257 and 3.791 MeV. Comparison of the proton angular distributions with PWBA predicted shapes indicated l_n = 2 for the levels at 0.097, 2.370, 3.160 and 3.237 MeV. Gamma radiation was observed with Ge(Li) detectors. Particle-γ and $\gamma-\gamma$ coincidence measurements were performed at E_d = 3 MeV. The gamma branching ratio of the 1.468 MeV state to the ground state has been found to be (3.1 ± 1.7)%. The present results are compared with previous work and discussed in the frame of the shell model. (auth)

39974 INVESTIGATION OF THE REACTION $^{19}F/d,\alpha/^{17}O$ WITH PLASTIC TRACK DETECTOR IN THE ENERGY REGION FROM 450 TO 300 keV. Mesko, L.; Schlenk, B.; Somogyi, Gy.; Valek, A. ATOMKI (At. Kut. Intez.) Kozlem., 11: 9-14(May 1969). (In Hungarian).

Angular distributions for α_0, α_1, α_2 and α_3 groups from the reaction $^{19}F/d, \alpha/^{17}O$ have been measured by plastic track detectors in the deuteron energy range 459-303 keV. Present work can be considered as a completion of previous measurements carried out by semiconductor detectors in the energy range 645-459 keV. It appears from the comparison of the two independent measurements at 459 keV that the plastic track detector can be used not only for determining relative angular distribution but also for measuring absolute cross section. (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 89

Refer also to abstracts 37922, 37993, 38298, 38300, 38306, 39126, 39559, 39585, 39773, 39941, 39950, 39955, 39956, 39963, 39969, 39971, 39994, 40058, 40102, 40131, 40141, and 40337.

39975 (COO-535-593) STUDY OF THE EFFECTIVE TWO-BODY FORCE USING THE $^{54}Fe(^3He,t)$ CHARGE EXCHANGE REACTION. Hayakawa, S. I.; Kraushaar, J. J.; Kunz, P. D.; Rost, E. (Colorado Univ., Boulder. Dept. of Physics and Astrophysics). [1969]. 13p. Dep. CFSTI.

Differential cross sections were measured for the $^{54}Fe(^3He,t)^{54}Co$ reaction at 37.5 MeV. The T = 1 states are well described using a conventional microscopic DWBA analysis with $(f_{\frac{7}{2}})^{-3}$ orbitals, but similar analysis of the T = 0 states indicates a serious discrepancy between theory and experiment. (auth)

39976 (ORNL-4395) PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1968. Stelson, P. H. (ed.) (Oak Ridge National Lab., Tenn.). May 1969. Contract W-7405-eng-26. 165p. Dep. CFSTI.

Work completed and in progress during 1968 by the Physics Division of Oak Ridge National Laboratory is reported. The work included nuclear reaction studies, nuclear structure and model studies, instrumentation studies, and elementary particle studies. (J.W.R.)

39977 (RLO-1925-25) THE 7416-keV 2^+ LEVEL IN ^{28}Si AND AN EXCITED PROLATE ROTATIONAL BAND. Gibson, E. F.; Goswami, A.; Huang, F.; McDaniels, D. K. (Oregon Univ., Eugene). [1969]. 9p. Dep. CFSTI.

Gamma coincidence measurements revealed decay modes of the 7416-keV 2^+ level in ^{28}Si to the 0^+ level at 4975 keV (3.7 ± 2.0%) and to the 2^+ level at 1779 keV (2.1 ± 0.6%). The existence of an excited prolate rotational band in ^{28}Si based on either the 4975- or 6691-keV 0^+ states with the 7416-keV level as the 2^+ member was ruled out on the basis of lifetime and branching ratio data. (auth)

39978 DOPPLER-SHIFT LIFETIME MEASUREMENTS IN ^{20}Ne, ^{24}Mg, AND ^{28}Si. Anderson, John Herbert. Charlottesville, Va., Univ. of Virginia, 1968. 213p.

Thesis.

The reactions $^{19}F(^3He,d)^{20*}Ne$, $^{23}Na(^3He,d)^{24*}Mg$, and $^{27}Al(^3He,d)^{28*}Si$ were used to obtain precise excitation energies and lifetimes of states in ^{20}Ne, ^{24}Mg, and ^{28}Si. Doubly ionized ^3He ions from a 5.5 MV Van de Graaff accelerator were used, with bombarding energies of up to 11 MeV. Gamma rays were detected by a germanium lithium-drifted detector. A total of 43 states were studied, including 5 in ^{20}Ne, 21 in ^{24}Mg, and 17 in ^{28}Si. The measured excitation energies of most levels are more accurate than the previously reported values. The Doppler-shift attenuation method was used to obtain the lifetimes of 3 levels in ^{20}Ne, 5 levels in ^{24}Mg, and 8 levels in ^{28}Si. A particle-gamma ray coincidence method was used in which lifetimes of several levels could be obtained simultaneously with the Doppler shifts approximately maximized. Gamma ray feeding from higher levels, which could affect the results, was shown to be negligible in all but two cases. Transition rates were calculated from these lifetimes and published branching ratios. Comparisons are made with the rotational model, the SU_3 model, the particle-hole model and the Hartree-Fock model. (Diss. Abstr.)

39979 A HIGH RESOLUTION STUDY OF ISOBARIC ANALOGUE STATES IN ^{41}K AND ^{23}Na. Keyworth II, George Albert. Durham, N. C., Duke Univ., 1968. 160p.

Thesis.

Cross sections for the elastic scattering of protons by ^{40}Ar from 1.63 to 2.60 MeV and by ^{22}Ne from 0.80 to 3.13 MeV were measured. In addition, reaction cross sections were measured wherever obtainable. The ^{40}Ar data were taken at 135° whereas the ^{22}Ne data were measured at 90, 105, 120, 135, 150 and 160°. Utilizing a cryogenic target chamber developed for these experiments, permitting detection of charged reaction products, an energy resolution of about 250 eV was realized. Two isobaric analogue states were seen in each of the compound systems, ^{41}K and ^{23}Na. In all cases, the analogue states were in evidence as a fragmentation of the broad $T_>$ analogue state into an enhancement of the background $T_<$ states. These individual fine-structure states were analyzed within the framework of R-matrix theory, and spins, parities, partial and total widths were determined. A total of approximately 200 resonances were observed and analyzed in this manner. Spectroscopic factors obtained from these measurements for the analogue states agree quite well with those previously measured for the parent states from (d,p) stripping on the same target nuclei. In addition, these definite spin and parity assignments resolve previous ambiguities regarding the J^π assignments to the parent states. (Diss. Abstr.)

39980 DIRECTIONAL CORRELATION OF GAMMA RAYS IN ^{72}Ge. Monahan, Wayne Gordon. Columbus, Ohio, Ohio State Univ., 1968. 109p.

Thesis.

The gamma rays of ^{72}Ge following the beta decay of 14.1 hour ^{72}Ga were studied using a 20-cm^3 Ge(Li) detector in coincidence with a 2'' × 2'' NaI(Tl) crystal. Major features of the decay scheme were confirmed by the coincidence measurements. Directional correlation measurements were carried out on the cascades involving the 630, 894, 1231, 2202, 2491 and 2508-keV gamma rays with the 834-keV ground-state transition from the first-excited 2^+ state. 1-3 directional correlation measurements (with the intermediate gamma ray unobserved) were made between gamma rays of energy 601, 786, 1000, 1051, 1215, 1597 and 1861 keV and the 834-keV transition. Spin assignments of 2 for the 1464 and the 3036-keV levels were confirmed. The 630 and 2202-keV transi-

tions are nearly pure E2 and E1 respectively. The level at 2065 keV was assigned a spin of 3. The 601-keV transition has a maximum M1 admixture of 10%. Using the fact that the 2515-keV level is a spin-3 state, the following spin and mixing assignments can be made. The level at 1728 keV is found to have a spin of 4 which requires a 1% octupole mixture in the 894-keV transition. The levels at 3325 and 3343 keV were assigned spins of 3 and 2 respectively. The 786, 1597, 2491 and 2508-keV transitions are all nearly pure E1. The interpretation of these results is given in terms of the pairing-plus-quadrupole model using the calculations of Kisslinger and Sorensen. (Diss. Abstr.)

39981 ANGULAR DISTRIBUTION OF ^{24}Na RECOIL NUCLEI PRODUCED IN THE REACTION ^{27}Al(p,3pn). Denisov, F. P.; Milovanov, V. P.; Pokrovskii, V. N.; Cherenkov, P. A.; Yutlandov, I. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 9: 930-2(May 1969). (In Russian).

Angular distribution of the ^{24}Na recoil nuclei produced when irradiating an Al target 0.27 mg/cm^2 and 2.43 mg/cm^2 thick by 660-MeV protons is measured in the region of 20 to 150° at collection angles ~12 and ~24°. (auth)

39982 ELASTIC AND INELASTIC PROTON SCATTERING FROM ^{40}Ca AND TWO-PARTICLE, ONE-HOLE STATES IN ^{41}Sc. Marinov, A.; Drory, Ch.; Navon, E.; Burde, J.; Engler, G. (Hebrew Univ., Jerusalem). Phys. Rev. Lett., 23: 23-6(July 7, 1969).

The elastic and inelastic scattering of protons by ^{40}Ca were studied at bombarding energies from 4.8 to 6.2 MeV. 60 resonances were identified. The spins of most of them and their partial widths for decay to the ground state and to the first four excited states in ^{40}Ca were determined. Levels in ^{41}Sc having configurations with a large two-particle, one-hole component were identified and compared with similar levels in ^{41}Ca. (auth)

39983 INELASTIC SCATTERING AND SUPERFLUID NUCLEUS MODEL. Inopin, E. V.; Mel'nik, Yu. P. (Physical-Technical Inst., Kiev). Yadern. Fiz., 9: 982-6(May 1969). (In Russian).

Analyzing experimental data on elastic and inelastic diffraction scattering of α particles with intermediate energies on nuclei, one is able to get information about the structural nuclear factors. Matrix elements for the nuclei ^{58}Ni, ^{64}Zn, ^{88}Sr, ^{90,96}Zr, ^{118,122}Sn at the excitation of one-phonon 2^+ states are calculated. An attempt is undertaken to interpret the structural nuclear factors on basis of the superfluid nucleus model. In the framework of the model, the results of calculations for the nuclei mentioned as well as for the nucleus ^{134}Ba are in satisfactory agreement with the data extracted from the experiment. (auth)

39984 DEUTERON EXCITATION FUNCTIONS FOR THE FORMATION OF ^{24}Na AND ^{22}Na FROM ^{23}Na BY USE OF NaCl–CARBON FOILS. Lange, J.; Muenzel, H.; Gantner, E. (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 11: 121-3(1969). (In German).

A simple technique for preparing thin target layers used in cyclotron irradiations is described. The target material is homogeneously distributed as a salt in a carbon matrix. Excitation functions for the formation of ^{24}Na and ^{22}Na from ^{23}Na are determined by irradiation of NaCl–carbon foils with 15 to 51.5 MeV deuterons. (auth)

39985 EXPERIMENTAL INVESTIGATIONS ON THE ELECTRON CAPTURE DECAY OF ^{85}Sr AND ^{88}Y. Grotheer, Horst-Henning; Hammer, Johann Wolfgang; Hoffmann, Klaus-Werner (Univ., Stuttgart). Z. Phys., 225: 293-302(1969). (In German).

The electron-capture decay of ^{85}Sr and ^{88}Y was investigated using NaI(Tl) detectors. Spectroscopic-coincidence techniques were employed to examine the K-electron capture rates. The experimental results are $P_K\omega_K(Sr) = 0.5959 \pm 0.0035$ and $P_K\omega_K(Y) = 0.6340 \pm 0.0032$. Using the K-capture probabilities derived from the capture ratios of Brysk and Rose with the exchange correction of Bahcall ($P_K(Sr) = 0.880 \pm 0.008$ and $P_K(Y) = 0.883 \pm 0.008$), one can derive from these results the fluorescence yields $\omega_K(Rb) = 0.677 \pm 0.009$ and $\omega_K(Sr) = 0.712 \pm 0.010$. Functions of $\omega_K(Z)$ were fitted to recent experimental data and tabulated for Z = 5 – 90. In addition to these results, the half-life of the 514-keV state of ^{85}Rb and the branching ratios and the positron rate of the ^{88}Y decay were measured with the same techniques. The data obtained partly disagree from measurements of other authors. (auth)

39986 NOTE ON THE DECAY OF ^{43}K. Taylor, H. W.; King, J. D.; Ing, H.; Cox, R. J. (Univ. of Toronto). Can. J. Phys., 47: 1539-42(July 15, 1969).

The gamma rays emitted by radioactive ^{43}K were observed with a Ge(Li) spectrometer. Gamma rays with energies (intensities) of 219.2 ± 0.7 (8 ± 3), 373.0 ± 0.5 (101 ± 5), 397.8 ± 1.0 (11 ± 3), 592.5 ± 1.2 (10 ± 2), and 617.2 ± 0.5 (81 ± 5) keV were identified. No direct evidence was found for gamma rays with energies of 388 and 1005 keV. A level scheme for ^{43}Ca was constructed with levels at 373.0 ± 0.5, 592.4 ± 0.8, and 990.2 ± 0.7 keV. (auth) (Canada)

39987 DECAY OF ^{77m}Ge. Imanishi, N.; Nakahara, H.; Ishibashi, M.; Fujiwara, I.; Nishi, T. (Kyoto Univ.). J. Inorg. Nucl. Chem., 31: 2284-8(July 1969).

It is stated that there is considerable discrepancy in reported data for the decay of ^{77m}Ge. This is believed to be due mainly to the fact that the 158-keV γ rays of ^{77m}Ge could not be sufficiently resolved from the 138-keV γ rays of ^{75m}Ge using a NaI(Tl) detector. Also, when β rays of ^{77m}Ge were followed to determine its half-life, β rays of ^{75m,g}Ge and/or ^{75g}Ge could have introduced error. In the measurements described a Ge(Li) detector was employed, connected to a 1024-channel TMC pulse-height analyzer. After counting, the daughter product ^{77}As was separated from other products and its 240- and 250-keV γ rays measured with a NaI(Tl) detector connected to a 400-channel pulse-height analyzer. The 138-keV photopeak of ^{75m}Ge was well separated from the 158-keV photopeak of ^{77m}Ge, and both showed one-component decay. 215-keV γ rays were emitted directly from the metastable state and from the ground state of ^{77}Ge and were analyzed. The decay was analyzed by a computer program, and the average half-life of ^{77m}Ge was determined as 55.5 ± 0.96 sec. The γ-ray energies were 158.3 ± 0.3 and 214.3 ± 0.3 keV. The intensity ratio of the 158-keV to the 215-keV γ rays emitted from ^{77m}Ge was observed to be 0.48 ± 0.01, and the ratio of the intensity of the 215-keV γ rays from ^{77m}Ge to total β rays emitted from the same species was found to be 0.27 ± 0.03. Log ft values are also reported. Studies were also conducted on ^{75m}Ge, giving a half-life of 48.9 ± 0.2 sec, and only 138-keV γ rays. (UK)

39988 THE ^{35}Cl(p,n)^{35}Ar THRESHOLD AND THE VECTOR INTERACTION IN THE DECAY ^{35}Ar(β^+)^{35}Cl. Freeman, J. M.; Robinson, D. C.; Wick, G. L. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 29B: 296-8(May 26, 1969).

A new measurement of the threshold for the reaction ^{35}Cl(p,n)^{35}Ar has given the value 6941.2 ± 1.7 keV. The beta end-point for the mirror transition ^{35}Ar(β^+)^{35}Cl is obtained as 4941.6 ± 1.7 keV. The calculation of a value for the vector coupling constant is discussed. (auth)

39989 THE HALF-LIFE OF ^{32}P. Pernaa, D. W. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Int. J. Appl. Radiat. Isotop., 20: 613-14(Aug. 1969).

Two sulfur pellets were exposed to fast neutron fluxes of ~10^{14} and 10^{13} n/cm^2 within the core of a pulsed reactor to obtain ^{32}P through the reaction ^{32}S(n,p)^{32}P. Over a period of 148 days the pellets were counted on a methane end-window counter (both with and without absorbers) and on a Beckman Widebeta II counter. The mean half-life of 14.32 days was obtained with a smaller spread than in previous measurements. (UK)

39990 CORRELATIONS IN THE ENERGIES AND WIDTHS OF STRUCTURE OBSERVED IN THE REACTIONS ^{40}Ca(γ,n_o)^{39}Ca AND ^{40}Ca(γ,p_o)^{39}K. Wu, C.-P.; Baglin, J. E. E.; Fink, F. W. K.; Phillips, T. W. (Yale Univ., New Haven). Phys. Lett., 29B: 359-61(June 9, 1969).

The ground-state differential cross sections at 90° for the (γ,n_o) and (γ,p_o) reactions in ^{40}Ca were measured. The energies and widths of intermediate-type structure observed in the two reactions are clearly correlated throughout the giant dipole resonance region. (auth)

39991 PROPERTIES OF THE 9.699 MeV LEVEL IN ^{28}Si. Anyas-Weiss, N.; Charlesworth, A. M.; Carlson, L. E.; Jackson, K. P.; Azuma, R. E. (Univ. of Toronto). Can. J. Phys., 47: 1725-9(Aug. 15, 1969).

The decay of the 9.699-MeV level in ^{28}Si was studied using the reaction ^{27}Al(p,γ)^{28}Si at E_p = 1724 keV. Gamma rays from the decay of the 9.699-MeV level were observed with large-volume Ge(Li) detectors. Branching ratios for the decay of the 9.699-MeV level were obtained, and a lower limit for the lifetime of this level was measured to be $\tau \geq 2.7$ ps using the Doppler-shift attenuation method. (auth) (Canada)

39992 THE ^{23}Na(α,γ)^{27}Al REACTION. A SURVEY OF THE REACTION AND SOME PROPERTIES OF THE ^{27}Al NUCLEUS. Roepke, H.; Anyas-Weiss, N. (Univ. of Toronto). Can. J. Phys., 47: 1545-55(Aug. 1, 1969).

The ^{23}Na(α,γ) reaction was studied in the region E_α = 2 to 3 MeV. The γ-ray spectra from a total of 16 resonances were surveyed using a 40-cm^3 Ge(Li) detector. Excitation energies, γ-ray decay modes, branching ratios, and γ-ray yields of these resonances are given. Below E_α = 2.7 MeV, all resonances have $J^\pi \geq 5/2^+$ and the α-particle proceeds with $l \geq 2$. The resonances

at E_α = 2.696 and 2.797 MeV have strong branches to the $J^\pi = 11/2^+$ state in ^{27}Al at 4.509 MeV excitation energy. A measurement of γ-ray angular distributions at these resonances yields J^π(2.969 res.) = $9/2^+$, $11/2$ and J^π(2.797 res.) = $9/2^+$, $7/2$ and J^π(4.580) = $9/2^+$, $7/2$ for bound states in ^{27}Al. Investigation of this latter level at the E_p = 2.114 MeV resonance in the ^{26}Mg(p,γ)^{27}Al reaction restricts the spin to $7/2$. New excited states in ^{27}Al were found at E_x = 5.504, 5.671, and 7.815 MeV. A state at E_x = 5.499 MeV was confirmed. (auth) (Canada)

39993 PROPERTIES OF THE 1.763 MeV LEVEL IN ^{35}Cl. Taras, P.; Matas, J. (Univ. of Montreal). Can. J. Phys., 47: 1605-16(Aug. 1, 1969).

Angular distribution and linear-polarization measurements were performed at the E_p = 3.115 and 3.345 MeV resonances in the reaction ^{35}Cl(p,p'γ)^{35}Cl. The spin and parity of the 1.763-MeV level in ^{35}Cl were deduced to be $5/2^+$ while the multipolarity mixing ratio of its decay to the ground state was found to be δ(E2/M1) = +2.64 ± 0.12. These results confirm that the possible E1 transition from the 3.163 to the 1.763 MeV level in ^{35}Cl is inhibited by a factor of at least 10^3. The properties of the 1.763-MeV level and the beta decay from ^{35}Ar to the first three levels in ^{35}Cl are found to be in quite good agreement with the predictions of the unified model. (auth) (Canada)

39994 STUDY OF THE EFFECTIVE TWO-BODY FORCE USING THE ^{54}Fe(^{3}He,t) CHARGE EXCHANGE REACTION. Hayakawa, S. I.; Kraushaar, J. J.; Kunz, P. D.; Rost, E. (Univ. of Colorado, Boulder). Phys. Lett., 29B: 327-31(June 9, 1969).

Differential cross sections were measured for the ^{54}Fe(^{3}He,t)^{54}Co reaction at 37.5 MeV. The T = 1 states are well described using a conventional microscopic DWBA analysis with $(f_{\frac{7}{2}})^{-2}$ orbitals, but similar analysis of the T = 0 states indicates a serious discrepancy between theory and experiment. (auth)

39995 STUDY OF NEUTRON DEFICIENT ISOTOPES PROPERTIES WITH DUBNA SYNCHROCYCLOTRON. Gromov, K. Ya.; Dzhelepov, B. S. At. Energ. (USSR), 26: 362-9(Apr. 1969). (In Russian).

A short review of the experimental investigations of the properties of excited and ground states of neutron-deficient isotopes obtained at 680 MeV irradiation in the Dubna synchrocyclotron is given. In a period of 1956–1967 numerous data on the decay schemes of the investigated isotopes were obtained. About 60 new isotopes and isomers were discovered. (auth)

39996 EXCITED STATES OF ^{21}Na IN THE NEIGHBORHOOD OF 5 MeV. Amiel, M.; Lambert, M.; Beaumevieille, H. (Institut d'Etudes Nucleaires, Algiers). Nuovo Cim., Lett., 1: 689-94 (May 11, 1969). (In French).

The levels of ^{21}Na in the neighborhood of E_{ex} = 5 MeV are not well known. One excited state was observed at E_{ex} = 4.99 ± 0.05 MeV through the reaction ^{20}Ne(d,n). In addition, a supposedly double resonance was observed at E_p = 2.73 MeV in the reaction ^{20}Ne(p,p), which corresponds to an excited state of ^{21}Na at 5.03 MeV. In order to determine the spins and parities of excited states of ^{21}Na between 4.8 and 5.2 MeV, the elastic and inelastic scattering of protons on ^{20}Ne at 2.5 and 2.8 MeV was studied. (tr-auth)

39997 PHOTODISINTEGRATION OF NICKEL ISOTOPES. Pai, H. L. (Univ. of Ottawa. Carleton Univ., Ottawa): McNeill, K. G. Can. J. Phys., 47: 1313-16(June 15, 1969).

The anomalies in the photoneutron cross sections of ^{58}Ni and ^{60}Ni found by Min and White are explained in terms of compound nucleus calculations using shell-independent parameters. (auth) (Canada)

39998 LIFETIME MEASUREMENTS OF THE SIX LOWEST LYING LEVELS IN ^{35}Cl. Ingebretsen, F.; Alexander, T. K.; Haeusser, O.; Pelte, D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 47: 1295-1306(June 15, 1969).

The energies, gamma-ray branching ratios, and mean nuclear lifetimes of the six lowest lying levels in ^{35}Cl were measured. Gamma rays following the reaction ^{32}S(α,pγ)^{35}Cl were studied using two Ge(Li) detectors with 15-cm^3 and 40-cm^3 active volumes respectively. The lifetimes of the five lowest lying levels were measured using the Doppler shift attenuation method, with the results: 1219 keV, $0.21^{+0.10}_{-0.08}$ ps; 1763 keV, 0.55 ± 0.15 ps; 2646 keV, 0.30 ± 0.09 ps; 2695 keV, <0.03 ps; and 3003 keV, <0.05 ps. The lifetime of the 3163-keV level was measured to be 60 ± 7 ps, using a recoil distance method. The level structure is discussed taking into account known lifetimes, spins, parities, and gamma-ray mixing ratios. (auth) (Canada)

39999 EFFECT OF COLLECTIVE STRUCTURE OF THE PRODUCT NUCLEUS STATE ON (d,α) EFFECTIVE CROSS SECTIONS IN THE sd SHELL. Hofmann, A.; Emmerich, W. -D.; Phillip, G. (Univ., Erlangen–Nuernberg, Ger.). Nucl. Phys., A131: 435-49(1969). (In German).

Cross sections of the (d,α) reactions on ^{23}Na, ^{25}Mg, ^{29}Si, and ^{31}P were measured at E_α = 10 and 11 MeV. The integrated cross sections of the reactions ^{23}Na(d,α)^{21}Ne and ^{25}Mg(d,α)^{23}Na can be written as $\sigma = \sigma_C + \sigma_D$. At a given bombarding energy, σ_D is nearly constant for the α-particle groups corresponding to the one rotational band; the 2I + 1 rule holds for σ_C. A simple band mixing correction is required. The behavior of the ^{29}Si(d,α)^{27}Al cross section indicates that ^{27}Al cannot be described exclusively either with the excited-core model or with the rotational model. In the ^{31}P(d,α)^{29}Si reaction no simple dependence on the excited states of the residual nucleus is found. (auth)

40000 OPTICAL-MODEL ANALYSIS OF 29 MeV ^{3}He DIFFERENTIAL CROSS-SECTION AND TOTAL REACTION CROSS-SECTION DATA. Baugh, D. J. (Australian National Univ., Canberra). Nucl. Phys., A131: 417-29(1969).

Differential cross sections and total reaction cross-section measurements for ^{3}He ions scattered by Mg, Al, ^{56}Fe, ^{63}Cu, and Ag targets were analyzed using the optical model. Discrete and continuous ambiguities are discussed. The inclusion of reaction cross-section measurements did not significantly resolve these ambiguities. (auth)

40001 DECAY OF ^{67}Cu. Raman, Subramanian; Pinajian, John J. (Oak Ridge National Lab., Tenn.). Nucl. Phys., A131: 393-7(1969).

The γ-rays following the β decay of ^{67}Cu were investigated with a high-resolution Ge(Li) detector. The ^{67}Cu was produced by double neutron capture on ^{65}Cu. Gamma rays of energies (and relative intensities) 91.26 (155), 93.25 (360), 184.53 (1000), 208.95 (2.4), 300.22 (15.7), and 393.60 (4.3) keV were observed. The γ rays were incorporated in a level scheme of ^{67}Zn with levels (and spins and parities at 0 ($5/2^-$), 93.3 ($1/2^-$), 184.5 ($3/2^-$), and 393.5 ($3/2^-$) keV. (auth)

40002 GAMMA DECAY OF ^{75}Se. Paradellis, T.; Hontzeas, S. (Univ. of Saskatchewan, Regina, Can.). Nucl. Phys., A131: 378-84(1969).

A study was made of the γ-ray spectrum of ^{75}Se using a variety of Ge(Li) detectors. The energies and intensities of 14 lines were measured: 24.4 keV (0.044 ± 0.006), 66.0 keV (1.72 ± 0.04), 96.7 keV (5.12 ± 0.10), 121.1 keV (27.7 ± 0.50), 136.0 keV (95.00 ± 1.80), 198.6 keV (2.38 ± 0.07), 264.6 keV (100.0), 279.5 keV (42.0 ± 0.80), 303.8 keV (2.19 ± 0.07), 400.5 keV (20.40 ± 0.50), 419.3 keV (0.023 ± 0.002), 468.6 keV (0.001 ± 0.0005), 572.6 keV (0.063 ± 0.002), and 617.7 keV (0.0075 ± 0.0002). Of these a 24.4-keV and 468.6-keV transition were substantiated for the first time in the γ-ray spectrum. The 80.8-keV transition deduced from electron conversion spectra and a 373 keV transition previously reported in the γ-ray spectrum of ^{75}Se were not observed. K x-ray intensities and branching ratios have been determined. The results of this work support the conclusions of previous studies in the decay of ^{75}Ge and in the Coulomb excitations of ^{75}As for the existence of a level at 468.6 keV. A modified γ-decay scheme of ^{75}Se to include the 468.6 level is proposed. (auth)

40003 ONE-PROTON AND TWO-PROTON STRIPPING BETWEEN ^{26}Mg, ^{27}Al, AND ^{28}Si. Bohne, W.; Fuchs, H.; Grabisch, K.; (and others) (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys., A131: 273-304(1969).

The reactions ^{26}Mg(He-3,n)^{28}Si and ^{27}Al(d,n)^{28}Si were investigated with the time-of-flight method at 5.7 and 6 MeV bombarding energy, respectively. Deuterons and α particles from the ^{26}Mg(He-3,d)^{27}Al and ^{26}Mg(He-3,α)^{25}Mg reactions at E_t = 11 MeV were detected in a solid-state counter telescope. Angular distributions are extracted, and for the one-nucleon transfer reactions, analyzed with DWBA to yield l-values and spectroscopic factors. These are compared to the results of previous measurements. Together with data from a previous ^{28}Si(n,d)^{27}Al study, the transition strengths of the one-proton transfer reactions are compared to the predictions of the unified model both in strong and weak coupling. The ^{26}Mg(He-3,d)^{27}Al results are compatible with a strong coupling description for a deformation η = 2 of both nuclei. The (n,d) as well the (d,n) reaction between ^{27}Al and ^{28}Si contradict both versions of the unified model. Predictions from a TDA treatment of p-h states in ^{28}Si are also compared to the ^{27}Al(d,n) strengths. The ^{26}Mg(He-3,n)^{28}Si data indicate an appreciable amount of core excitation in the ^{28}Si ground state. (auth)

40004 INELASTIC SCATTERING OF NEUTRONS. II. COMPARISON OF QCN THEORY WITH EXPERIMENT. Bertram, W. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aust. J. Phys., 22: 145-53(Apr. 1969).

The cross section for inelastic scattering of neutrons by medium and heavy target nuclei is derived using the quasi-compound nucleus theory. Calculations are carried out for ^{56}Fe and ^{60}Ni. The results of these calculations are compared with experiment. Agreement between theory and experiment is quite good for scattering to the continuum of high levels and to discrete levels with small spins. On the other hand the theory underestimates the scattering to levels with large spin values. (auth) (Australia)

40005 ANGULAR CORRELATION STUDIES OF THE LOW-LYING LEVELS OF ^{29}Al. Kean, D. C.; Carter, K. W.; Piluso, C. J.; Spear, R. H. (Australian National Univ., Canberra). Nucl. Phys., A132: 241-53(1969).

The 1.40, 1.76, 2.23, 2.87, 3.07, 3.19, and 3.44 MeV levels of ^{29}Al were studied via angular correlation measurements of the reaction ^{26}Mg(α,pγ)^{29}Al. Limitations are imposed on possible spins and on multipole mixing ratios of associated gamma-ray transitions. (auth)

40006 THE l = 3 AND 4 TRANSITIONS IN INELASTIC SCATTERING OF PROTONS FROM ^{66}Zn. Yagi, K.; Saji, Y.; Ishizaki, Y.; Ishimatsu, T.; Nakajima, Y.; Matoba, M.; Huang, C. Y. (Tokyo Univ.). Nucl. Phys., A132: 690-4(1969).

Elastic and inelastic scatterings of protons from ^{66}Zn have been studied at 55.01 MeV incident energy. Scattered protons have been analyzed and detected by a broad-range magnetic spectrometer with a 200 proportional counter system. No strongly excited states have been observed in the excitation energy $E_x > 6$ MeV. Angular distributions are analyzed in terms of the DWBA method. In addition to the well-known first 2^+ and 3^- states, six l = 3 transitions with reduced transition rates of $2 \sim 1$ in a single particle unit are observed for excitation energies in the 4.1 to 5.7 MeV region. Two l = 4 transitions are also observed for excitation energies of 3.08 and 4.70 MeV. (auth)

40007 (^{3}He,α) REACTION ON ^{22}Ne, ^{24}Mg, AND ^{26}Mg AT 15 MeV. Joyce, J. M.; Zurmuehle, R. W.; Fou, C. M. (Univ. of Pennsylvania, Philadelphia). Nucl. Phys., A132: 629-48(1969).

Measurements are reported of the angular distributions of alpha particles from the (^{3}He,α) reaction on ^{26}Mg, ^{24}Mg and ^{22}Ne leading to low-lying states in ^{25}Mg, ^{23}Mg and ^{21}Ne. The angular distributions of 15 MeV ^{3}He elastically scattered from ^{26}Mg, ^{24}Mg and ^{22}Ne have also been measured. Optical-model analysis of the elastic scattering and DWBA analyses of the reaction angular distributions have been performed and spectroscopic factors extracted. (auth)

40008 THE REACTION ^{23}Na(p,p) IN THE RANGE 8.0 TO 12.0 MeV. I. ANALYSIS OF AVERAGE ELASTIC CROSS SECTIONS. Hellstroem, J.; Dallimore, P. J.; Davidson, W. F. (Australian National Univ., Canberra). Nucl. Phys., A132: 581-92(1969).

Absolute differential cross sections have been measured for the elastic scattering of protons from ^{23}Na. Excitation functions were measured in 20 keV steps for incident proton energies from 8.0 to 12.0 MeV and at 23 different angles. Average angular distributions every 0.5 MeV were obtained from smooth fits to the excitation functions; these were analyzed using the optical-model and Hauser–Feshbach theories. The variations with energy of the optical-model potentials, the compound-nucleus reduction factor and the amount of compound nucleus and direct reaction cross sections have been investigated. There is some evidence for the presence of intermediate structure in the compound nucleus ^{24}Mg. (auth)

40009 THE ft VALUE OF THE SUPERALLOWED FERMI BETA DECAY ^{26m}Al(β^+)^{26}Mg. Freeman, Joan M.; Jenkin, J. G.; Murray, G.; Robinson, D. C. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys., A132: 593-610(1969).

The threshold for the reaction ^{26}Mg(p,n)^{26m}Al has been measured in terms of the accurately known energies of the α-particle groups from a ThC source. The result $E_{th} = 5208.5 \pm 1.7$ keV corresponds to a Q-value of -5013.5 ± 1.6 keV. The weighted mean of this and an earlier independent Q-value measurement gives for the endpoint in the beta decay ^{26m}Al(β^+)^{26}Mg the result 3208.6 ± 1.3 keV. The half-life for the beta decay has been measured as 6.346 ± 0.005 sec. The ft value for the transition is thus found to be 3081 ± 7 sec, including radiative corrections. This result is lower than those for other superallowed Fermi decays. It corresponds to a value for the vector coupling constant $G_V^2 = (1.4129 \pm 0.0016) \times 10^{-49}$ erg · cm^3. The value inferred for the Cabibbo angle is $\cos\theta_V^2 = 0.985 \pm 0.001$, excluding uncertainties in the radiative corrections. This result appears to differ appreciably from the value inferred from the rate of $K^+ \rightarrow \pi^0 e^+ \nu$ decay. (auth)

40010 AN ANALYSIS OF THE ^{27}Al(p,α)^{24}Mg AND THE ^{23}Na(p,α)^{20}Ne DIRECT REACTION PROCESS AT 41.3 MeV AND 45.5 MeV. Kost, C. J. (Univ. of Manitoba, Winnipeg); Hird, B. Nucl. Phys., A132: 611-24(1969).

The angular distributions of several alpha-particle groups from the reaction ^{27}Al(p,α)^{24}Mg have been obtained at 41.3 ± 0.5 MeV and of the ground state group of the reaction ^{23}Na(p,α)^{20}Ne, at 45.5 ± 0.5 MeV. A general characteristic of the shape of these angular distributions is the lack of pronounced diffraction oscillations in contrast with (p,α) reactions in lighter nuclei. No evidence was found for a rise of the differential cross section at backward angles. A finite range DWBA analysis, using independently obtained optical model parameters for the most part, was able to fit the shape of the angular distributions quite well. Values of the spectroscopic factors were obtained which are in good agreement with shell-model predictions. (auth)

40011 THE DECAY OF ^{68}Cu AND ^{68}Ga. Vaughan, K.; Sher, A. H.; Pate, B. D. (Simon Fraser Univ., Burnaby, B. C.). Nucl. Phys., A132: 561-70(1969).

The decay of the nuclides ^{68}Cu and ^{68}Ga, both populating levels in ^{68}Zn, has been studied by means of Ge(Li) and NaI(Tl) gamma-ray detectors. The ^{68}Cu half-life of 31.64 ± 0.98 sec and the energies of the 577.8, 805.7, 1077.4, 1262.1, 1744.8 and 1883.7 keV gamma-rays from ^{68}Cu decay have been measured to a much greater precision than possible previously. The energies of gamma-rays from ^{68}Ga decay have been confirmed. Gamma-gamma coincidence measurements with Ge(Li) and NaI(Tl) detectors have confirmed the existence of 578 to 1077 keV, 806 to 1077 keV, 1262 to 1077 keV and 1745 to 1077 keV cascades in ^{68}Zn. These results and those for β-intensities and log ft values are discussed in terms of the ^{68}Cu and ^{68}Ga decay schemes. (auth)

40012 CROSS-SECTIONS FOR THE (^{4}He,^{3}H) STRIPPING REACTION ON Fe, Al, C, AND GLASS TARGETS AT AN ENERGY OF 120 MeV. Anand, K. C.; Daniel, R. R.; Stephens, S. A. (Tata Inst. of Fundamental Research, Bombay). Solar Phys., 8: 152-4 (July 1969).

Iron, aluminum, carbon, and glass targets were irradiated with 120-MeV helium ions. The cross sections for the stripping reaction (^{4}He,^{3}H) on these target nuclei were determined, with nuclear emulsions, as 85 ± 30, 65 ± 20, 38 ± 15 and 41 ± 15 mb, respectively. (auth)

40013 NUCLEAR RESONANT SCATTERING OF GAMMA RAYS IN Ni, Cd, Sn, AND Bi. Cesareo, R.; Giannini, M.; Oliva, P.; Prosperi, D.; Ramorino, M. C. (CNEN, Rome). Nucl. Phys., A132: 512-28(1969).

The nuclear resonant scattering of monochromatic γ-rays has been studied by means of a 30 cm^3 Ge(Li) detector. The γ-source was provided by the (n,γ) reaction in iron and copper. Natural Ni, Cd, Sn and Bi targets have been used as scatterers. Several de-excitation γ-rays from the resonant levels in Ni, Cd and Sn have been observed. In addition to the well known resonant levels, six new ones have been detected in ^{209}Bi, Ni and Sn. Angular distribution measurements of the elastically and inelastically scattered photons have been performed. The spectrum of the low-energy γ-rays in coincidence with the inelastically scattered photons was measured by means of two NaI(Tl) counters. Consistent level schemes for ^{62}Ni, ^{112}Cd and ^{118}Sn have been deduced. (auth)

40014 DIRECTIONAL CORRELATION MEASUREMENTS IN ^{24}Mg(^{3}He,pγ)^{26}Al. Bissinger, G. A.; Quin, P. A.; Chagnon, P. R. (Univ. of Notre Dame, Ind.). Contract Nonr-1623(05). Nucl. Phys., A132: 529-47(1969).

Directional correlation measurements with a cylindrically symmetric reaction geometry on the ^{24}Mg(^{3}He,pγ)^{26}Al reaction lead to the following definite spin assignments: J = 1 for the 3719 keV level, J = 2 for the 2913 and 3159 keV levels, J = 3 for the 2365 and 2545 keV levels and J = 5 for the 3405 keV level. A probable spin assignment J = (2) is suggested for the 3745 keV level, and the spin of the 3074 keV level is limited to J = 3 or 2. Evidence for a doublet near 3960 keV is presented. Gamma-ray decay modes for the members of the doublet (labeled the 3950 and 3960 keV levels) have been deduced from the p-γ two-parameter spectra. Directional correlation measurements on the γ-rays de-exciting these levels restrict the spin of the 3950 keV level to J = 3 or 1 and the spin of the 3960 keV level to J = 1 or 0 (in order of preference). Branching ratios of each level and multipole mixing ratios for each transition determined from the directional correlations are reported. (auth)

40015 LIFETIMES OF ^{39}K EXCITED STATES: THE $2s_{\frac{1}{2}}$ HOLE STATE. Robertson, B. C.; Gill, R. D.; Bell, R. A. I.; l'Ecuyer, J.; Rose, H. J. (Nuclear Physics Lab., Oxford). Nucl. Phys., A132: 481-8(1969).

The lifetimes of the first three excited states of ^{39}K have been investigated using the DSAM. The 2.53 MeV level has $\tau_m = 105 \pm 32$ fsec; the 2.82 MeV level has $\tau_m > 6$ psec; the 3.02 MeV level has $\tau_m < 54$ fsec. The results are compared with previous experimental data and model predictions. (auth)

40016 MEASUREMENT OF K$^-$-MESONIC X-RAY SPECTRA OF MEDIUM AND HEAVY ELEMENTS. Wiegand, Clyde E.

(Univ. of California, Berkeley). Phys. Rev. Lett., 22: 1235-8 (June 9, 1969).

Lines of the kaonic x-ray spectra of 24 elements ranging from Z = 17 to Z = 92 were measured. Kaons are absorbed at the nuclear surface from circular orbits. The sudden cut-off of transitions to successively lower principal quantum numbers at certain values of Z indicates that nuclear matter (probably neutrons) extends above the conventional nuclear surfaces. A peak in one of the spectra corresponds to x rays from Σ^--hyperonic atoms. (auth)

40017 COMPOUND AND DIRECT PROCESSES IN PROTON ELASTIC SCATTERING FROM ^{31}P AND ^{62}Ni. Dallimore, P. J.; Davidson, W. F.; Hellstroem, J. (Australian National Univ., Canberra). Nucl. Phys., A132: 287-304(1969).

Absolute differential cross sections were measured for the elastic scattering of protons from ^{31}P and from ^{62}Ni. For ^{31}P the measurements were taken in 10 keV steps from 8.00 to 8.20 MeV and at 27 angles. For ^{62}Ni six angular distributions were measured between 8.00 and 8.05 MeV. The averaged angular distributions have been analyzed using the optical model and Hauser–Feshbach theories. The effect of reducing the Hauser–Feshbach contribution to allow for direct interaction competition was investigated. (auth)

40018 RADIOACTIVE DECAY OF ^{73}Se AND ^{73m}Se. Marlow, K. W. (Instituut voor Kernphysisch Onderzoek, Amsterdam. Naval Research Lab., Washington, D. C.); Faas, A. Nucl. Phys., A132: 339-52(1969).

The radioactive decay of ^{73}Se ($T_{\frac{1}{2}}$ = 7.2 h) and ^{73m}Se ($T_{\frac{1}{2}}$ = 39 min) has been studied with the aid of semiconductor radiation detectors. Both singles and coincidence spectra have been recorded. Decay schemes are proposed incorporating 17 gamma rays for the 7.2 h activity and 32 gamma rays for the 39 min activity. The unobserved isomeric transition was shown to occur in 73% of the decay from the growth of the 7.2 h activity. (auth)

40019 COULOMB EXCITATION OF ^{45}Sc. Goldberg, M. D.; Hooton, B. W. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys., A132: 369-73(1969).

Coulomb excitation of ^{45}Sc has been studied with 25 MeV ^{16}O and 40 MeV ^{35}Cl ions. From thick-target yields of de-excitation gamma rays, B(E2)↑ = 70 ± 7, 81 ± 20 and 330 ± 100 $e^2 \cdot fm^4$ has been deduced for the 376, 720 and 1237 keV levels, respectively; B(E1)↓ = (1.47 ± 0.15) × 10^{-4} $e^2 \cdot fm^2$ has been deduced for the 376 → 12 keV transition. From a measurement of the angular distribution of de-excitation gamma rays, J(720 keV) = $\frac{5}{2}$ has been assigned. (auth)

40020 ^{28}Mg AND ^{29}Mg IN AN INTERMEDIATE COUPLING SU_3 MODEL. Stewart, K. W. C.; Castel, B. (Queen's Univ., Kingston, Canada). Nucl. Phys., A132: 445-54(1969).

The spectra of ^{28}Mg and ^{29}Mg are calculated in an intermediate-coupling version of the SU_3 model. The variation of level positions with spin-orbit strength ξ is investigated. The best agreement with experiment is found for small ξ in ^{28}Mg and very large ξ in ^{29}Mg. Some of the electromagnetic decays in ^{29}Mg are investigated and compared with recent experimental data. (auth)

40021 PHOTONUCLEAR REACTIONS OF Al, Si, P, S, Cl, K, AND Ca WITH PRODUCTION OF ^{24}Na. Noga, V. I.; Ranyuk, Yu. N.; Sorokin, P. V. (Physical-Technical Inst., Kharkov). Yadern. Fiz., 9: 1152-4(June 1969). (In Russian).

Cross sections of the reactions ^{27}Al → ^{24}Na, ^{28}Si → ^{24}Na, ^{31}P → ^{24}Na, ^{32}S → ^{24}Na, ^{35}Cl → ^{24}Na, ^{39}K → ^{24}Na, ^{40}Ca → ^{24}Na are measured at the γ-quanta energies from 100 up to 1200 MeV by means of the activation method. The energy dependence of the cross sections is shown to be in agreement with the meson mechanism of the reactions. (auth)

40022 POLARIZATION IN ELASTIC SCATTERING OF PROTONS ON Si AT 2.6 TO 4.0 MeV. Soroka, V. I.; Pucherov, N. N. (Inst. of Physics, Kiev). Yadern. Fiz., 9: 1159-62 (June 1969). (In Russian).

Polarization of protons elastically scattered on ^{28}Si under the angles 50, 60, and 100° in l. s. at 2.6 – 4.0 MeV, is measured. Polarization is calculated using the results of analysis of experimental data on the cross section of the p – ^{28}Si scattering. Experimental value of the polarization is in agreement with the calculations assuming the level ^{29}P at E_p = 3.98 MeV to have the spin and parity $\frac{1}{2}^+$, and at E_p = 3.71 MeV – $\frac{1}{2}^-$. In the region of the wide resonance at E_p = 2.88 MeV the proton polarization under the angle Θ_{lab} = 60° achieves 50% and varies slowly with the energy. (auth)

40023 DECAY OF ^{61}Co AND ^{63}Co. Kiselev, B. G.; Levkovskii, V. N. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 9: 1113-15(June 1969). (In Russian).

By means of a semiconductor γ spectrometer and a scintillation β spectrometer, the decay of ^{61}Co and ^{63}Co resulting from irradiation of ^{61}Ni and ^{64}Ni by fast neutrons, was studied. In the ^{61}Co spectrum there were γ lines with the energy (in brackets the intensities in % per decay are given) 67 ± 0.5(96); 850 ± 1.0(0.90); 917.5 ± 1.0(4.1) keV. In the ^{63}Co spectrum there is one γ line with the energy 81.9 ± 0.5 keV. End-point energy of the ^{63}Co β spectrum is found to be 3500 ± 50 keV. (auth)

40024 INVESTIGATION OF THE REACTION MECHANISM OF THE ^{32}S(d,pα)^{29}Si GROUND-STATE REACTION AT BOMBARDING ENERGIES OF 12.0 AND 17.0 MeV. Burke, John Andrew. Pittsburgh, Univ. of Pittsburgh, 1968. 48p.

Thesis.

The ^{32}S(d,pα)^{29}Si g.s. reaction was studied at bombarding energies of 12.0 and 17.0 MeV. Coincident protons and alpha particles were detected using solid state detectors, and their correlated energy spectra were analyzed by a 64 × 64 channel pulse-height analyzer. Measurements were carried out at various angular combinations (θ_p,θ_α). The angular dependence of the differential cross section and the shapes of the energy spectra were compared with the results of some simple model calculations. It was found that at a bombarding energy of 12.0 MeV, the reaction proceeds mainly by a double evaporation process, although for small proton angles a significant contribution of a direct (d,p) reaction, followed by an alpha evaporation, is visible. At a bombarding energy of 17.0 MeV the reaction mechanism is predominantly the latter direct-evaporation process. (Disser. Abstr.)

40025 DECAY OF ^{74}As. Hamilton, J. H. (Vanderbilt Univ., Nashville); Coffman, F. E.; Ramayya, A. V.; Johnson, Noah R. Nucl. Phys., A132: 254-64(1969).

Gamma-ray spectrum and γ–γ directional correlation measurements were performed with Ge(Li) and NaI-Ge(Li) detector arrangements on the decay of ^{74}As. Eleven transitions from 595.7 to 2198.4 keV were observed and fitted into levels at 595.7 ± 0.1, 1204.3 ± 0.1, 1463.2 ± 1.0, 1482.6 ± 0.5, 1697.3 ± 1.0, and 2198.2 ± 0.5 keV in ^{74}Ge and 634.8 ± 0.1 keV in ^{74}Se. Directional correlation measurements were performed on the 608-596 keV 2-2-0 cascade and on the 887-596 keV cascade. In the first case, A_2 = −0.24 ± 0.04, A_4 = 0.30 ± 0.05. These data yielded a (7$^{+2}_{-3}$)% M1 admixture for the 608 keV transition. For the latter correlation, values of A_2 = 0.6 ± 0.2 and A_4 = 1.3 ± 0.2 were found. These values are compatible only with the 0-2-0 cascade and thus the level at 1482.6 keV has spin zero. Percent feedings and log ft values were calculated for decays to ^{74}Ge and ^{74}Se. (auth)

40026 RADIATIVE CAPTURE AND TOTAL CROSS SECTIONS OF NEUTRON INTERACTION WITH Se ISOTOPES. Maletski, Kh.; Pikel'ner, L. B.; Salamatin, I. M.; Sharapov, E. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 1119-28(June 1969). (In Russian).

The transmission and radiative capture of neutrons on separated Se isotopes were measured on the pulse reactor IBR with a microtron. Parameters of levels up to 10 + 20 keV for the four even and up to 4 keV for an odd Se isotope are obtained. For ^{77}Se the spins of 15 levels with $\Gamma_n > \Gamma_\gamma$ are determined. The values of the strength function S_0, mean distances between levels and mean radiative widths $\overline{\Gamma_\gamma}$ are found. Spin dependence S_0 and $\overline{\Gamma_\gamma}$ for ^{77}Se in the region up to 4 keV was not observed. (auth)

40027 STUDY OF GAMMA-RAY SPECTRA OF THERMAL-NEUTRON CAPTURE IN ^{147}Sm, ^{149}Sm, AND ^{152}Sm. Reddingius, E. R.; Postma, H. (Kamerlingh Onnes Laboratorium, Leiden, Reactor Centrum Nederland, Petten). Physica, 40: 567-80 (Jan. 20, 1969).

The gamma-ray spectra following thermal-neutron capture in ^{147}Sm, ^{149}Sm and ^{152}Sm were investigated with a 6.4-cc Ge(Li) detector. Samples enriched in ^{147}Sm and ^{152}Sm were used. It is shown that all the observed transitions in the spectrum of natural Sm, except the 5740 keV transition, are due to neutron capture in ^{149}Sm. Relevant parts of the decay schemes of ^{148}Sm and ^{153}Sm are proposed. The neutron-binding energies of ^{148}Sm, ^{150}Sm and ^{153}Sm were determined to be 8140.0 ± 1.2, 7985.2 ± 0.8 and 5867.0 ± 0.4 keV respectively. (auth)

40028 ANGULAR DISTRIBUTION, LIFETIME, AND BRANCHING RATIO MEASUREMENTS IN THE ^{31}P(p,γ)^{32}S REACTION. Piluso, Carl Joseph. Eugene, Oreg., Univ. of Oregon, 1968. 191p.

Thesis.

The recent availability of large-volume, high-resolution Ge(Li) detectors has made possible much more precise gamma-ray measurements than were previously possible with NaI detectors. The present study involves the exploitation of this excellent resolution in branching ratio, lifetime, and angular distribution measurements in the ^{31}P(p,γ)^{32}S reaction. Gamma-ray spectra were measured with a 20 cc Ge(Li) detector at the 1.248-, 1.438-, 1.556-, and 1.583-MeV resonances in the ^{31}P(p,γ)^{32}S reaction to

determine the energies and branching ratios of the levels populated in ^{32}S. The results of these measurements indicate the population of 5 levels which had not previously been observed in this reaction: 5.410, 6.664, 7.188, 7.485, and 7.952 MeV. The observed gamma decay of the 5.410-MeV level is in agreement with the results of (p,p′) studies; the decay of the other 4 levels has not previously been reported. The lifetimes of 9 levels in ^{32}S were determined by measuring the Doppler shifts of the gamma rays emitted by the bound states at the 1.556- and 1.438-MeV resonances. The substantial difference in the measured lifetimes of the 6.623- and 6.664-MeV levels supports the proposed population of both members of the doublet in the (p,γ) reaction. Angular distributions of the stronger primary and secondary gamma rays were obtained with the Ge(Li) detector at the 1.248- and 1.438-MeV resonances. To determine spins and mixing ratios involved in the decays, the experimental data were analyzed by χ^2 methods with a computer program which calculates the theoretical distributions as a function of formation and decay mixing ratios. The method of analysis and the utility of Ge(Li) detectors for such measurements are discussed. The nucleus ^{32}S seems to exhibit the phenomenon of nuclear coexistence, similar to but in an inverted order from that which has been suggested for ^{16}O. It is conjectured that in ^{32}S the 0^+ ground state and 2^+ first-excited state are members of a rotational band, while the 0^+ 3.780-MeV level is a spherical configuration. According to this model, the interaction between the spherical and deformed 0^+ states mixes them and accounts for the transitions from the 3.780-MeV level to the (deformed) 2.230-MeV first-excited state. The measured life-times of the 2.230- and 3.780-MeV levels indicate a qualitative agreement with this model when compared with a simple calculation of the mixing of the two 0^+ states. (Disser. Abstr.)

40029 γ-RAY SPECTRA FROM THE REACTION (n,n′γ) ON Fe, Y, La, Ce, AND Tm. Romanenko, V. M.; Sit'ko, S. P.; Strizhak, V. I.; Shevchenko, V. A. (Kiev State Univ.). Yadern. Fiz., 9: 1129-37(June 1969). (In Russian).

Spectra of γ rays emitted at the inelastic scattering of 2.75-MeV neutrons on natural Fe, Y, La, Ce, and Tm are studied by means of the techniques of electronic collimation of neutrons from the reaction $D(d,n)^3He$. The obtained results are compared with the other data. The relative intensity of the emitted γ rays is estimated. (auth)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 37922, 37954, 38027, 38298, 38668, 39560, 39773, 39941, 39955, 39956, 39976, 39983, 39995, 40013, 40029, 40086, and 40111.

40030 (AHSB(S)R–169) REVISED FISSION CROSS SECTION EVALUATIONS FOR THE ENERGY RANGE 1 keV TO 15 MeV. Hart, W. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). 1969. 32p. Dep. CFSTI. UK 5s. 6d.

The remaining regions of major uncertainty are associated with the ratio measurements (relative to ^{235}U) rather than the absolute determination of the ^{235}U cross section. The discrepancies are most dramatic below about 80 keV in which range much reliance was placed on the 24-keV measurements of Perkin et al. [NSA 19: 35416]. Revised cross sections are tabulated. (auth) (UK)

40031 (KURRI-TR-12, pp 3-17) EXPERIMENTAL DATA ACCUMULATED TO DATE ON THE ELECTRIC POLARIZABILITY OF NEUTRONS. Ito, Eigen (Kyoto Univ. (Japan)). (In Japanese).

Soviet scientists discovered in 1956 that elastic scattering of neutrons by heavy nuclides such as U and Th, results in abnormally large differential scattering cross sections at some forward angles. Many attempts have been made since then to assign this phenomenon to the electric polarizability of neutrons. There is still considerable controversy whether these abnormal measurements are reliable and whether this behavior may be explained on the basis of electric polarizability. The most important experimental results to date are compared, presenting also some of the problems which must be resolved before a clear cut picture can be drawn, specially, the problem of the accuracy of the measurements. In the author's opinion, the experimental data reported by the Soviets are difficult to analyze because the incident energy of pile neutrons used in the study were not known accurately. The other problems are mixing in of inelastic scattering and the corrections to be made for Schwinger scattering and elastic scattering as a result of nuclear forces. The reliability of these theoretical calculations must be carefully assessed. There is also a need to explain why this anomaly appears at high but not at low incident energy. There also seems to be a correlation between the atoms exhibiting this anomaly and their fissionable nature. It is concluded that although the data do not allow to draw definitive conclusions they are instrumental in indicating experimental studies. (TTT)

40032 (UUIP-628) THE 371 keV $2^+ - 2^+$ TRANSITION IN ^{190}Os INVESTIGATED BY ELECTRON-ELECTRON AND GAMMA-ELECTRON DIRECTIONAL CORRELATIONS. Samuelsson, L.; Vukanovic, R.; Migahed, M.; Zupancic, M.; Edvardson, L. O.; Westerberg, L. (Uppsala Univ. (Sweden). Inst. of Physics). Mar. 1969. 26p. Dep.

Electron-electron directional correlation measurements were made on the 2^+(371 keV), 2^+(187 keV), 0^+ cascade in ^{190}Os. The magnitude of electric monopole to quadrupole mixing ratio for the 371-keV transition was determined to be $q(E0/E2) = -0.06(12)$ for $\lambda = 1$. (Sweden)

40033 (UUIP-648) NUCLEAR SPINS OF NEUTRON-DEFICIENT HOLMIUM AND ERBIUM ISOTOPES. Ekstroem, C.; Noreland, T.; Olsmats, M.; Wannberg, B. (Uppsala Univ. (Sweden). Inst. of Physics). June 1969. 37p. Dep.

The atomic-beam magnetic-resonance method was used to measure the nuclear spins of some neutron-deficient holmium and erbium isotopes with the following results for Ho (mass number, halflife, spin): (154, 12m, 1), (155, 50m, 5/2), (156, 55m, 1), (157, 14m, 7/2), (158, 11m, 5), (158^m, 29m, 2), (159, 33m, 7/2), (160, 26m, 5), (160^m, 5.0h, 2), (162, 15m, 1), (162^m, 68m, 6), (164, 29m, 1), (164^m, 38m, 6), and for Er: (157, 20m, 3/2), (158, 2.3h, 0), (159, 36m, 3/2), (161, 3.2h, 3/2). The investigated nuclei are located in a region of nuclear deformation, and the nuclear spins were interpreted in terms of the unified nuclear model. (Sweden)

40034 (UUIP-650) LIFETIMES OF EXCITED STATES OF ^{193}Ir. Lindskog, J.; Vaelivaara, K-G.; Awwad, Z.; Haegglund, S-E.; Marelius, A.; Phil, J. (Uppsala Univ. (Sweden). Inst. of Physics). July 1969. 14p. Dep.

The lifetimes of four excited states in ^{193}Ir were measured by a delayed coincidence technique. The following results were obtained: 73.0-keV level: $T_½ = 6.3 \pm 0.2$ ns, 138.9-keV level: $T_½ = 74 \pm 11$ ps, 180.0-keV level: $T_½ = 80 \pm 30$ ps, 460.5-keV level: $T_½ = 14 \pm 9$ ps. Furthermore upper limits of the lifetimes of the doublet 557-559 keV were shown to be 557.3-keV level: $T_½$ less than or equal to 50 ps, 559.2-keV level: $T_½$ less than or equal to 200 ps. A comparison was made between experimental and theoretical M1-transition probabilities for the transitions deexciting the 138.9- and 180.0-keV levels. (auth) (Sweden)

40035 DETERMINATION OF THE HALF-LIFE OF ^{210}Pb. Hoehndorf, A. (Bundesanstalt fuer Bodenforschung, Hanover). Z. Naturforsch., 24a: 612-15(Apr. 1969). (In German).

The half-life of ^{210}Pb was calculated from measurements of the specific activity and the ^{210}Pb concentration of a ^{210}Pb solution. The specific ^{210}Pb activity was determined by measuring the daughter product ^{210}Po using an α-spectrometric isotope dilution method with ^{208}Po as tracer. The ^{210}Pb-concentration was measured by mass-spectrometric isotope dilution analysis. A half-life of 22.26 ± 0.22 ($=2\sigma$) years was obtained. (auth)

40036 HALF-LIVES OF K-FORBIDDEN TRANSITIONS IN EVEN-EVEN NUCLEI OF THE RARE EARTH REGION. Hoenig, V. (Univ., Freiburg i. B.). Z. Phys., 225: 327-35(1969). (In German).

The half-life of the 1.490 MeV level in ^{162}Dy was measured in the decay of ^{162m}Ho (68 min) by delayed coincidences of KX rays and (900–1,300) keV gamma radiation to be (1.94 ± 0.19) nsec. A half-life in ^{176}Hf was remeasured in the decay of ^{176}Ta(8.1h) by delayed coincidences of KX rays and (1,100–1,200) keV gamma radiation to be (4.75 ± 0.25) nsec. In order to fix the level with this half-life in the level scheme of ^{176}Hf, the gamma spectrum delayed to KX rays was measured. It is suggested that probably the 1.2274 MeV level of ^{176}Hf is delayed and has the spin 2^- or 3^+. (auth)

40037 CONVERSION COEFFICIENTS AND FLUORESCENCE YIELDS IN THE DECAY OF ^{199m}Hg. Kloppenburg, Juergen (Univ., Goettingen, Ger.). Z. Phys., 225: 364-75(1969). (In German).

^{199m}Hg was produced by bombarding natural HgO with fast neutrons. The conversion electrons of the cascade decay were investigated with Si(Li) counters. By application of the summing technique, the conversion coefficients and L-shell fluorescence yields of Hg were determined. The gamma rays were studied with a Ge(Li) counter. The following results were obtained: half-life $T_½ = (42.6 \pm 0.2)$ min; energies of the transitions $E_{γ1} = (374.1 \pm 0.1)$ keV, $E_{γ2} = (158.3 \pm 0.1)$ keV; intensity ratio of the gamma rays $I_γ(158\text{ keV}) : I_γ(374\text{ keV}) = (424 \pm 42) : 100$; conversion coefficients $\alpha_{K158} = 0.30 \pm 0.03$, $\alpha_{total\,158} = 0.94 \pm 0.09$, $\alpha_{K158}/\alpha_{LM...158} = 0.47 \pm$

0.02, $\alpha_{L158}/\alpha_{M...158} = 3.10 \pm 0.16$; $\alpha_{K374} = 3.51 \pm 0.28$, $\alpha_{total374} = 6.19 \pm 0.47$, $\alpha_{K374}/\alpha_{LM...374} = 1.32 \pm 0.04$, $\alpha_{L374}/\alpha_{M...374} = 2.14 \pm 0.11$; L-shell fluorescence yields $\bar{\omega}_L = 0.40 \pm 0.04$, $\omega_{KL} = 0.41 \pm 0.04$. (auth)

40038 NUCLEAR QUADRUPOLE MOMENTS OF THE STABLE ISOTOPES ^{185}Re AND ^{187}Re. Krause, H.; Krebs, K.; Winkler, R.; Zschimmer, M. (Technische Univ., Berlin). Naturwissenschaften, 56: 84(Feb. 1969). (In German).

The 6s 6p z $^6p_{\frac{9}{2}}$ state of ^{185}Re and ^{187}Re was investigated with a double Fabry–Perot interferometer. The results of hyperfine structure splitting factors are tabulated. These improved values permitted the calculation of the nuclear quadrupole moments without previous assumptions, and the values obtained were $Q(^{185}Re) = 2.3_8 \pm 0.5$ barn and $Q(^{187}Re) = 2.2_4 \pm 0.5$ barn. (J.S.R.)

40039 E1, $\Delta K = 0$ TRANSITIONS IN DEFORMED ODD-MASS NUCLEI. Vetter, M. (Univ., Freiburg i. B.). Z. Phys., 225: 336-52(1969). (In German).

The half-lives of the $\frac{5}{2}\frac{5}{2}^-[523]$ level at 25.7 keV in ^{161}Dy and the $\frac{5}{2}\frac{5}{2}^+[642]$ level in ^{163}Er, found to lie at 69.2 keV, were determined by the delayed coincidence method to be $T_{\frac{1}{2}} = 27.8 \pm 1.5$ nsec and $T_{\frac{1}{2}} = 8.8 \pm 0.5$ nsec, respectively. The following hindrance factors relative to the single-particle Weisskopf estimate (F_W) and the Nilsson estimate (F_N) were obtained: ^{161}Dy $\frac{5}{2}\frac{5}{2}^-[523] \rightarrow \frac{5}{2}\frac{3}{2}^+[642]$: $F_W = (6.6 \pm 1.3) \times 10^3$, $F_N = 0.48 \pm 0.10$; and ^{163}Er $\frac{5}{2}\frac{5}{2}^+[642] \rightarrow \frac{5}{2}\frac{5}{2}^-[523]$: $F_W = (2.4 \pm 0.5) \times 10^4$, $F_N = 1.8 \pm 0.4$. A systematic difference between transitions in odd-proton nuclei and odd-neutron nuclei was found: E1, $\Delta K = 0$ transitions in odd neutron nuclei have hindrance factors F_N from 2.9 to 0.16; this means that these transitions are in agreement with the predictions of the Nilsson model within a factor of 10. For transitions in odd proton nuclei one has hindrance factors F_N from 75 to 9.9×10^{-4}. It is shown that a small difference between the deformation of the initial and the final state changes the transition probability of both, proton and neutron transitions, considerably. (auth)

40040 ANGULAR DISTRIBUTIONS OF FRAGMENTS OF THE FISSION OF ^{238}Pu BY 0.06 TO 7.20 MeV NEUTRONS. Shpak, D. L.; Stepanov, D. N.; Smirenkin, G. N. (Physical-Power Engineering Inst., Obninsk, USSR). Yadern. Fiz., 9: 940-8(May 1969). (In Russian).

Angular distributions of fragments of the ^{238}Pu fission by 0.06 to 7.20 MeV neutrons are measured in detail by means of the track methods (glass detectors). Experimental data show the stable form of $W(\theta) = 1 + A\cos^2\theta$ from the very fission threshold and can be explained in terms of concepts of the two-peak barrier. The data on the energy dependence of the angular anisotropy reveal an essentially irregular character and correspond to the step-wise change of the K_0^2 parameter. In the vicinity of the (n,n'f) reaction threshold there is a dip of the angular anisotropy practically up to zero. (auth)

40041 EFFECT OF ^{238}U NUCLEUS EXCITATION ENERGY ON THE YIELD AND KINETIC ENERGIES OF PHOTOFISSION FRAGMENTS. Petrzhak, K. A.; Tutin, G. A. (Leningrad Technological Inst.). Yadern. Fiz., 9: 949-54(May 1969). (In Russian).

Kinetic energy distributions of the pair fragments of ^{238}U fission by bremsstrahlung with $E_{\gamma\,max} = 12.1$ MeV were measured. Mass distributions of fragments at different kinetic energies are obtained. The results obtained are compared with the $E_{\gamma\,max} = 25$ MeV data previously obtained under the same experimental conditions. Results of the comparison are in agreement with the hypothesis of two independent fission modes with different mean kinetic energies. (auth)

40042 POSITIVE IDENTIFICATION OF TWO ALPHA-PARTICLE-EMITTING ISOTOPES OF ELEMENT 104. Ghiorso, A.; Nurmia, M.; Harris, J.; Eskola, K.; Eskola, P. (Univ. of California, Berkeley). Phys. Rev. Lett., 22: 1317-20(June 16, 1969).

Isotopes of element 104 formed by bombarding ^{249}Cf with ^{12}C and ^{13}C ions were studied. ^{257}104 and ^{258}104 were positively identified by milking their daughters, ^{253}No and ^{255}No. ^{257}104 is a 4.5-sec alpha-particle activity with a complex spectrum; ^{258}104 is likewise an alpha emitter with a half-life of 3 sec. ^{259}104 is tentatively identified as an 11-msec spontaneous-fission activity. (auth)

40043 ANOMALOUS VARIATIONS OF THE NUCLEAR CHARGE RADII FOR Ba ISOTOPES. Sumbaev, O. I.; Mezentsev, A. F.; Marusbenko, V. I.; Ryl'nikov, A. S.; Ivanov, G. A. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 9: 906-13 (May 1969). (In Russian).

Variations of the charge radii $\Delta\langle r^2\rangle$ for barium isotopes are measured by the method of isotopic shift of the x-ray lines. The results are -0.37 ± 0.13 for ^{134,136}Ba, -0.10 ± 0.06 for $^{134-138}$Ba, -0.01 ± 0.12 for ^{136,137}Ba, and $+0.26 \pm 0.06$ for $^{136-138}$Ba. The anomalies are detected analogous to those known in cases of $^{40-48}$Ca and $^{86-88}$Sr. Correlating the obtained values of the x-ray shifts with the data determined by the isotopic shift of the optical lines, one gets the experimental value of the specific mass shift of the optical line ($6s^2\ ^1S_0 - 6s6p - ^3P_1$, Ba^I): $(+1.8 \pm 0.7) \cdot 10^{-3}$ cm^{-1}, that is in sharp disagreement with the theoretical value accepted before ($-5.2 \cdot 10^{-3}$ cm^{-1}). Correlation of deformations of the barium isotopes, necessary to explain the observed anomalies, with the accepted experimental and theoretical values shows that the anomalies appear not to be interpretable with the deformations only. (auth)

40044 SIMPLE NUCLEAR REACTIONS ON THE SEPARATED ISOTOPES OF TELLURIUM AT 300 MeV. Schall, Roy Franklin Jr. Pittsburgh, Carnegie-Mellon Univ., 1968. 82p.
Thesis.

Cross sections for (p,2p), (p,pn), and (p,2n) reactions on the seven heaviest separated isotopes of tellurium were measured at 300 MeV. The results were compared with a similar study on cadmium isotopes at 400 MeV. Results of this work indicate that both the (p,2p) and (p,pn) reactions are the result of a clean knock-out mechanism as expected. The (p,2p) reaction cross sections further indicate that the charge density at the nuclear skin, the site of these simple nuclear reactions, shrinks with the addition of neutrons to the nucleus. The (p,pn) reaction cross section may be explained on the basis of knockout of neutrons filling the $1h_{\frac{11}{2}}$ level in the tellurium isotopes (as well as those in the filled $3s_{\frac{1}{2}}$, $2d_{\frac{3}{2}}$, $1g_{\frac{7}{2}}$, and $1g_{\frac{9}{2}}$ levels). Cross sections for the (p,2n) reactions on tellurium isotopes seem to indicate a weak dependence on the number of neutrons available in the topmost levels of the tellurium isotopes. More data are needed to confirm this dependency, however. (Diss. Abstr.)

40045 MEASUREMENT OF SOME NUCLEAR PARAMETERS IN THE RADIOACTIVE DECAY OF ^{103}Ru, ^{193}Os, ^{191}Os, AND ^{155}Sm. Agin, Gary Paul. Manhattan, Kan., Kansas State Univ., 1968. 96p.
Thesis.

The radiations emitted by radioactive ^{103}Ru, ^{193}Os, ^{191}Os, and ^{155}Sm were studied with Ge(Li) and scintillation detectors. The object was the finding of new gamma-ray transitions, measurement of gamma-ray intensities, measurement of an internal conversion coefficient, and the construction of disintegration schemes. Many details of the gamma ray spectra which were unobserved in earlier investigations are now detectable with the use of Ge(Li) detectors. Investigation of gamma de-excitation characteristics of excited nuclei and the establishment of nuclear energy levels is essential for testing nuclear models. The gamma rays emitted in de-excitation of ^{103}Rh following beta decay of ^{103}Ru were studied in a Ge(Li) detector and with coincident scintillation counters. Quanta were detected at energies of 53, 297, 445, 498, 557, and 610 keV with relative intensities of 0.41, 0.31, 0.40, 100, 0.87, and 7.35. The data also indicate the presence of a gamma ray at 65 keV. The K-shell conversion coefficient of the 53-keV gamma ray was measured to be 1.77 ± 0.03. A disintegration scheme for ^{103}Ru has been proposed. The energies and relative intensities of the gamma rays of ^{193}Os ($T_{\frac{1}{2}} = 32$H) were measured with a Ge(Li) detector. Gamma-gamma coincidences and beta-gamma coincidences were studied to obtain energies of nuclear states in ^{193}Ir. In all, twenty-four detected gamma transitions have been ordered between eleven nuclear energy states. The energies of these transitions are 73, 98, 107, 139, 180, 219, 252, 281, 289, 299, 322, 362, 379, 388, 420, 438, 461, 486, 512, 533, 559, 574, 713, and 874 keV, establishing excited energy states at 73, 139, 180, 362, 438, 461, 559, 680, 713, and 874 keV in the nucleus of ^{193}Ir. Gamma rays corresponding to transition energies of 618, 780, and 830 keV were also observed, but these transitions could not be suitably incorporated into the disintegration scheme. ^{191}Os was produced by slow neutron capture in ^{190}Os. A gamma ray at 187 keV was emitted from the irradiated target material, but its intensity was found to decay with a half-life different from that of ^{191}Os. Isotopically concentrated ^{154}Sm was irradiated in a research reactor to produce ^{155}Sm which decays by beta emission to ^{155}Eu. A total of 29 gamma rays observed in Ge(Li) detectors was ordered in a level scheme which contains levels having the following excitation energies in keV, spins, and parities: $0(\frac{5}{2}^+)$, $79(\frac{3}{2}^+)$, $105(\frac{5}{2}^-)$, $168(\frac{7}{2}^-)$, $246(\frac{3}{2}^+)$, $307(\frac{5}{2}^+)$, $614(\frac{7}{2}^-)$, $768(\frac{5}{2}^+)$, $782(\frac{3}{2}^+)$, $876(\frac{5}{2}^+)$, $1102(\frac{9}{2}^-)$, $1264(\frac{7}{2}^-, \frac{9}{2}^+, \frac{9}{2}^+)$ and $1302(\frac{7}{2}^-, \frac{9}{2}^+, \frac{9}{2}^+)$. These states of ^{155}Eu were assigned Nilsson numbers or rotational properties. (Diss. Abstr.)

40046 BETA–GAMMA DIRECTIONAL CORRELATIONS IN ^{160}Tb AND ^{192}Ir. Seubert, James Walton. Bloomington, Ind., Indiana Univ., 1968. 97p.
Thesis.

Measurements were made on some beta-gamma directional correlations in ^{160}Tb and ^{192}Ir. The work on ^{160}Tb was undertaken to try to further the use of anomalous allowed decays in the study of

nuclear matrix elements. The beta transition involved was the 566-keV decay from the 3^- ground state to the 2^- state at 126-keV in ^{160}Dy. Measurements were made on this beta group in coincidence with two separate gamma rays, one at 299-keV and the other at 1178-keV. The first correlation resulted in a zero anisotropy. The second correlation was very small, at most 2%, and positive. Two different analyses were attempted to see if any information could be obtained from the minimal information of this one experiment. In both analyses, the second-forbidden matrix elements $\int \gamma_5 \vec{r}$ and $\int \vec{\alpha} \times \vec{r}$ were kept. In one analysis, $\int A_{ij}$ was also retained while in the other, the coordinate matrix elements $\int \vec{\sigma} r^2$ and $\int (\vec{\sigma} \cdot \vec{r}) \vec{r}$ were kept. In the analysis in which $\int A_{ij}$ was kept, difficulties were encountered in explaining very small anisotropies and resulted in matrix elements whose ratio to $\int \vec{\sigma}$ were between 0.1 and 1.0. In the other method of analysis, where coordinate matrix elements were retained, the ratios of the matrix elements to $\int \vec{\sigma}$ were of the order of 10^{-3} to 10^{-2}. The conclusion was that with minimal data, as was available here, only rough order of magnitude estimates are possible. Furthermore, there is no really clear way of saying which method of analysis gives more valid answers. A calculation of matrix elements was made on the basis of the Nilsson model. It was found that a rough order of magnitude agreement is obtained with the second method of analysis used. It was also found that the transition can be explained by a small (0.1%) impurity in the ground state of ^{160}Tb. In the decay of ^{192}Ir, measurements were made on the 536 keV β group in coincidence with the 605-keV + 612-keV gamma rays. It was found that the anisotropy for this transition is zero. This measurement can therefore shed no light on the ground state of ^{192}Ir. Measurements were also made on the K-conversion line of 316-keV transition in ^{192}Ir in coincidence with the 605-keV gamma ray. A very large value of the anisotropy was found and from this a value of the E2/M1 ratio of the 605-keV gamma ray was obtained. The result was $\delta = 0.7 \pm 0.2$. A discussion of ^{192}Ir and the daughter ^{192}Dy in terms of both the single-particle shell model and the Nilsson model is presented. (Diss. Abstr.)

40047 PHOTONEUTRON CROSS SECTIONS OF POLARIZED ^{165}Ho. Kelly, Michael A. Berkeley, Calif., Univ. of California, 1968. 89p.

Thesis.

The (γ,n) and (γ,2n) cross sections of polarized ^{165}Ho were measured between 10 and 20 MeV using the nearly mono-energetic photon beam from the Livermore linear accelerator. Two independent cross sections were obtained by orienting the polarization axis perpendicular to and parallel to the photon beam direction. From these, the cross sections corresponding to the intrinsic modes of the giant resonance are computed. The target consisted of nine single crystals of holmium metal, having a total mass of 50 g and was polarized by cooling to approximately 0.13°K in the presence of the 15-kOe field. The alignment parameter f_2 was determined to be 0.43 ± 0.05 by measuring the anisotropy of the gamma rays emitted by ^{166m}Ho (created in the target by neutron activation). The total photoneutron cross section, $\sigma_t = \sigma(\gamma,n) + \sigma(\gamma,2n) + \sigma(\gamma,np)$, exhibited an anisotropy in both major peaks of the giant resonance that agrees qualitatively with the collective model for deformed nuclei. An elementary version of the collective model and the dynamic collective model predict an anisotropy 22 to 26% larger than was observed. (Diss. Abstr.)

40048 STUDIES OF SOME ANOMALOUS ALLOWED AND FIRST FORBIDDEN BETA DECAYS. Kemper, Kirby Wayne. Bloomington, Ind., Indiana Univ., 1968. 112p.

Thesis.

The beta-gamma directional correlation coefficient ϵ was measured as a function of beta ray energy for the allowed 580 keV group in ^{154}Eu, the allowed 700 keV group in ^{152}Eu, the first forbidden unique 2290 keV group in ^{144}Pr, and the first forbidden nonunique 2200 keV group in ^{140}La. The two allowed transitions have isotropic correlations, which prohibit a quantitative determination of the matrix elements producing the beta transitions. The correlation measured in the ^{144}Pr decay was found to be 30% below the theoretically predicted value at 850 keV. The discrepancy between the experimental and theoretical values decreased as the beta ray energy was increased, with the two results becoming equal at 1950 keV. The beta-inner bremsstrahlung contribution to the measured correlation was computed from the Knipp–Uhlenbeck theory. When the correlation data were corrected for this effect, the full unique beta-gamma directional correlation was obtained. The ^{140}La measurements were performed in the beta energy range 1700 keV to 2000 keV. In this range the reduced anisotropy $\epsilon W/p^2$ was independent of energy and a representative data point was $\epsilon = 0.089 \pm 0.009$ at an energy of 1900 keV. Two sets of nuclear matrix elements which reproduce the directional correlation data, the shape factor data, and the beta-gamma circular polarization data were determined for the ^{140}La transition. The matrix element analysis was carried out with electron radial wave functions corrected for the finite nuclear size and the finite de Broglie wavelength of the electron as well as with electron radial wave functions that did not contain these corrections. Within the uncertainties in the nuclear matrix elements, the two analyses yielded the same values. (Diss. Abstr.)

40049 PROTON STRENGTH FUNCTIONS FOR Sn AND THE OPTICAL MODEL BELOW THE COULOMB BARRIER. Johnson, C. H.; Kernell, R. L. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 23: 20-3(July 7, 1969).

Proton strength functions were determined from the (p,n) reactions for 3- to 5.5-MeV protons on ^{117,119,120,122,124}Sn. The 3p size resonance was found. Optical-model analyses show that the energy dependence in the real well is 3 times greater for 5- to 10-MeV protons than for 10- to 16-MeV protons. The best-fit potential for 3- to 5.5-MeV protons has a surface absorptive layer about half as thick as at 10 MeV. (auth)

40050 RATIO OF STATIC ELECTRIC-QUADRUPOLE MOMENTS OF K = 3 AND K = 0 STATES IN ^{172}Yb. Li-Scholz, A.; Rasera, R. L. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett., 23: 181-4(July 28, 1969).

The ratio of the electric-quadrupole interaction frequencies between the 3^+ 1174-keV state and the 79-kev 2^+ state was measured using time-differential perturbed angular correlation techniques. The measured ratio $\omega_0(1174)/\omega_0(79) = 0.53 \pm 0.06$ corresponds to a ratio of the static quadrupole moments of Q(1171)/Q(79) = 1.33 ± 0.15, which, combined with the value of Q(79) derived from Coulomb-excitation transition probabilities, yields a value of Q(1174) = 2.92 ± 0.33 b. (auth)

40051 DETERMINATION OF THE HALF-LIFE OF ^{231}Pa BY MICROCALORIMETRY. Robert, J.; Miranda, C. F.; Muxart, R. (Institut de Physique Nucleaire, Paris. Laboratoire d'Arcueil, France). Radiochim. Acta, 11: 104-8(Apr. 1969). (In French).

The half-life of ^{231}Pa was determined by means of the adiabatic microcalorimetry developed by Lecoin and Robert. The value was found to be 32713 ± 110 years. (auth)

40052 RADIOCHEMICAL STUDIES OF 3 AND 14.8 MeV NEUTRON INDUCED FISSION OF ^{231}Pa. Birgul, O.; Lyle, S. J. (Univ. Chemical Lab., Canterbury, Eng.). Radiochim. Acta, 11: 108-12(Apr. 1969).

The cumulative yields of 10 nuclides from the fission of ^{231}Pa by 3.0 ± 0.4 MeV neutrons were measured radiochemically using a recoil method. The yields obtained agree well with those previously reported by Iyer et al. All fit on a highly asymmetric yield curve having a peak to trough ratio of about 100 and a peak width at half-height of 14 mass units. The maxima of the light and heavy peaks fall at masses 91 and 138 with peak yields around 7.2%. The relative widths for exactly symmetric fission and for neutron re-emission are compared with a term depending on the energies available for both processes in a correlation previously demonstrated for 14-MeV and now extended to 3-MeV neutron induced fission of heavy nuclides. ^{231}Pa appears to be an exception, and the fission cross sections for 14.8-MeV neutrons estimated to be 1.4 ± 0.1 barns by a radiochemical method is used in a discussion of this result. (auth)

40053 NEUTRON RESONANCES OF Gd ISOTOPES. Karzhavina, E. N.; Nguyen Nguyen Phong; Popov, A. B. (Joint Inst. of Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 897-905 (May 1969). (In Russian).

Transmission and radiative capture by the isotopes ^{152,154,155,156,157,158,160}Gd are measured by means of a neutron spectrometer. Parameters of the neutron resonances of the isotopes are obtained by means of the method of "area" analysis. Data on the resonance parameters are presented. Values of mean distance between the levels D, of strength function S_0, of mean radiative width Γ_γ, and of the parameter of the level density a are given for the Gd isotopes. Mean distances between the levels of the isotopes ^{152}Sm and ^{154}Sm are also given. For these isotopes measurements of the neutron radiative capture are fulfilled that makes it possible to determine the position of the neutron resonances. (auth)

40054 SEARCH FOR DELAYED NEUTRON PRECURSORS AMONG THE NOBLE GASES. Krisyuk, I. T.; Usacheva, N. T.; Shpakov, V. I. Yadern. Fiz., 9: 670-1(Mar. 1969). (In Russian).

Estimates show that the iodine and bromine contributions to the emission of delayed neutrons are only 30 to 50% of the total. Hence, there is a possibility that the short-lived isotopes of krypton and xenon may be precursors of delayed neutrons. A solution containing 35 g of uranium was irradiated in a volume of about 70 ml, and argon was passed through the solution to remove the noble gases. The carrier argon gas was scrubbed in a solution of Mohr's salt and of silver nitrate in nitric acid in order to remove halides. The

absolute fission yield was determined by counting the ^{139}Ba and ^{140}Ba activities. A total of about 3% of the over-all yield of delayed neutrons was found in the noble gas fraction, but the neutron activity in the condensed argon gas was so low (about 50 counts) that it was not possible to identify the xenon or krypton isotopes by half-lives. Further experiments on a search for delayed neutron precursors will be necessary to explain the problems associated with delayed neutrons. (TTT)

40055 THE SPIN OF THE 2.516 MeV LEVEL OF ^{140}Ce. Cords, H. (Australian National Univ., Canberra). Aust. J. Sci., 31: 366-7(Apr. 1969).

Arguments are presented for the existence of a level in ^{140}Ce at an excitation energy of 2.5161 MeV, and a spin of 4 is assigned. The mixing ratio of the 432.5-keV gamma depopulating this level is $\delta(E_2/M_1) = 0.032 \pm 0.009$. (Australia)

40056 EXISTENCE OF 1-MIN ^{101}Nb NOT CONFIRMED. Harbour, R. M.; Troutner, D. E. (Univ. of Missouri, Columbia. Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 31: 2273-5(July 1969).

Attempts were made to measure the fractional cumulative yield (FCY) of the reported (1 ± 0.2)-min ^{101}Nb from the thermal-neutron fission of ^{235}U and the spontaneous fission of ^{252}Cf. Initial separations of ^{101}Nb from ^{101}Mo were made at 1- and 10-min intervals after fission. The results indicated that approximately the same small amount of ^{101}Nb was present at 1 min after fission as at 10 min. These experiments were repeated in an attempt to set an upper limit for the FCY of a (1 ± 0.2)-min ^{101}Nb. The experiments indicated that 1-min ^{101}Nb is not a product of either ^{235}U or ^{252}Cf fission. (auth) (UK)

40057 YIELDS AND RECOIL PROPERTIES OF SCANDIUM ISOTOPES PRODUCED IN THE INTERACTION OF 590 MeV AND 18 GeV PROTONS WITH URANIUM. Ravn, H. (CERN, Geneva). J. Inorg. Nucl. Chem., 31: 1883-90(July 1969).

Absolute cross sections and some thick target recoil properties were measured for the production of $^{43-48}$Sc in uranium bombarded with protons of 590 MeV and 18 GeV, using radiochemical and electromagnetic isotope separation techniques. The yield of the neutron-deficient isotopes ^{43}Sc and ^{44}Sc increased by about a factor of 10 relative to ^{48}Sc when the proton energy was increased from 590 MeV to 18 GeV. The average kinetic energy of the products calculated from the recoil results was 79 ± 4 MeV for both neutron-rich and neutron-deficient products at 590-MeV proton energy. At 18 GeV, the average kinetic energy of the neutron-rich products was 52.7 ± 1.0 MeV, whereas the kinetic energy of the most neutron-deficient product observed, ^{43}Sc, had decreased to only 34.6 ± 1.0 MeV. New determinations of the half-lives of seven scandium isotopes were made on isotopically separated samples. (auth) (UK)

40058 AVERAGE CROSS SECTIONS AND HALF-LIVES OF ^{197m}Au AND ^{89m}Y EXCITED BY INELASTIC SCATTERING OF REACTOR NEUTRONS. Durrani, S. A.; Koehler, W. (Technische Hochschule, Munich). J. Nucl. Energy, 22: 632-6(Oct. 1968).

Samples of gold foil and of Y_2O_3 were irradiated in a rabbit facility in the FRM reactor. Gamma spectra were obtained by means of a NaI(Tl) detector and recorded on the first four 100-channel subgroups of a 1600-channel analyzer. Typical sets of curves are shown. The cross sections for reactor neutrons and the half-lives were found to be 379.8 ± 10.3 mb and 7.1 ± 0.2 sec for Au and 128.4 ± 3.3 mb and 15.9 ± 0.3 sec for Y. The results compared favorably with calculations made from excitation curves. (UK)

40059 DECAY AMPLITUDES OF ANALOG RESONANCES BY (p,p'γ) CORRELATION METHODS. Abramson, E.; Plesser, I.; Vager, Z.; Wurm, J. P. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Lett., 29B: 304-5(May 26, 1969).

It is shown that the angular correlations between decay protons from analog resonances and subsequently emitted γ rays yield complete information regarding decay amplitudes. Results of a ^{106}Cd(p,p'γ) correlation experiment via a $\frac{1}{2}^+$ analog resonance are discussed. (auth)

40060 THE CALCULATION OF THE g-FACTOR FOR 3^- STATE IN ^{208}Pb. Manahov, L.; Krainov, V. (Atomic Energy Inst., Moscow). Phys. Lett., 29B: 343-4(June 9, 1969).

The g-factor for the collective 3^- state in ^{208}Pb is calculated by the method of finite Fermi systems. The value g = 0.5 ± 0.2 was obtained. This g-factor is defined by the orbital proton motion only. The spin part of the g-factor is found to be very small. This value disagrees with the experimental result: g^{exp} = 0.08 ± 0.12. (auth)

40061 STUDY OF THE NUCLEAR LEVELS OF ^{222}Ra EXCITED IN THE α DECAY OF ^{226}Th. Briand, Jean-Pierre; Chevallier, Pierre; Touati, Alain (Institut de Physique Nucleaire, Paris). Compt. Rend., Ser. B, 268: 1105-8(Apr. 21, 1969). (In French).

The nuclear levels of ^{222}Ra are studied. An octupole vibration level of spin 3^- is ascertained; the second rotational term in the ground-state band is determined. (tr-auth)

40062 NUCLEAR ELECTRIC QUADRUPOLE MOMENTS OF ^{131}Cs AND ^{132}Cs BY OPTICAL DOUBLE RESONANCE SPECTROSCOPY OF THE 7 $^2P_{\frac{1}{2}}$-STATE. Schenck, A. (Univ., Heidelberg). Z. Phys., 224: 461-85(1969). (In German).

The hyperfine splitting of the 7 $^2P_{\frac{1}{2}}$ state of the radioactive isotopes ^{131}Cs and ^{132}Cs was investigated by optical double resonance. The hyperfine interaction constants deduced from the measured hfs transition frequencies are

	^{131}Cs	^{132}Cs
A(7 $^2P_{\frac{1}{2}}$)	+31.73(6) MHz	+25.03(12) MHz
B(7 $^2P_{\frac{1}{2}}$)	−28.63(35) MHz	+23.60(60) MHz

These values yield spectroscopic nuclear quadrupole moments Q_s (corrected for the Sternheimer effect) of $Q_s(^{131}Cs) = -0.57(1)$ barn and $Q_s(^{132}Cs) = +0.47(1)$ barn. The magnetic interaction constant A of ^{132}Cs results in a slightly improved precision of the nuclear magnetic dipole moment $\mu_I(^{132}Cs) = +2.22(1)\ \mu_K$. The cesium isotopes were produced by (d,xn) reactions on natural xenon. Total cross sections of the reactions ^{132}Xe(d,2n)^{132}Cs; ^{134}Xe(d,4n)^{132}Cs; ^{134}Xe(d,2n)^{134}Cs; ^{136}Xe(d,4n)^{134}Cs; ^{136}Xe(d,2n)^{136}Cs were measured between 10 and 29 MeV. (auth)

40063 ISOMERIC CROSS SECTIONS OF A(p,γ) REACTION. Yoshizawa, Y.; Fukushima, S.; Takehana, Y.; Komoto, H. (Osaka Univ.). Genshikaku Kenkyu, 13: 583-4(Feb. 1969).

Measurements were made of the ^{92}Mo(p,γ)^{93,93m}Tc reaction in a proton energy range 5 to 13 MeV. Particular attention was paid to see if any abrupt change appears in the m/g ratio around 7.3 MeV, where the ^{92}Mo(p,n) reaction begins to compete with the (p,γ) reaction. (auth)

40064 NUCLEAR CHARGE DISPERSION IN THE FISSION OF ^{233}U BY PROTONS OF MEDIUM ENERGY. Tomita, I.; Yaffe, L. (McGill Univ., Montreal). Can. J. Chem., 47: 2921-32(Aug. 15, 1969).

Independent yields and excitation functions were determined for the formation of cesium isotopes with masses $129 \leq A \leq 138$ in the fission of ^{233}U with protons of energies between 20 and 80 MeV. The energies at which the various excitation functions reach their maxima were compared with those obtained for the same isotopes from fissioning systems with targets of different neutron-to-proton (N/Z) ratios. The neutron-deficient species have a higher probability of being produced at lower energies from targets with lower N/Z ratios. Charge dispersion curves were obtained and these show the familiar broadening and displacement of Z_p, the most probable charge, towards stability with increase in bombardment energy. Values of $Z_A - Z_p$ were compared with those obtained from other fissioning systems, and predictions made for values of Z_p in the fission of systems yet unstudied, e.g., ^{235}U and ^{239}Pu. In addition Z_p values were calculated for ^{233}U fission, assuming compound nucleus formation up to a proton energy of 50 MeV, assuming pre- and post-fission neutron evaporation on the equal charge displacement and unchanged charge division postulates. Experimental values were found to lie between the two predictions. (auth) (Canada)

40065 MASS DISTRIBUTION IN THE FISSION OF ^{233}U BY 14.8 MeV NEUTRONS. Borden, K. D.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem., 31: 2623-5 (Aug. 1969).

The ^{233}U fission yields at 14.8-MeV neutron energy were measured for twenty-two mass chains. The mass distribution is intermediate between those of 14 to 15 MeV neutron-induced fission of ^{232}Th and ^{238}U. A third peak observed in the 14.8-MeV neutron-induced fission of ^{232}Th and in the 25 to 40 MeV helium-ion-induced fission of ^{233}U was not observed in the fast neutron-induced fission of ^{235}U. (auth) (UK)

40066 AN ACCURATE CALORIMETRIC DETERMINATION OF THE HALF-LIFE OF ^{204}Tl. Bortels, G. (Central Bureau for Nuclear Measurements, Geel, Belgium). Int. J. Appl. Radiat. Isotop., 20: 612-13(Aug. 1969).

^{204}Tl decays ~98% by β^- emission (E_{max} = 0.765 MeV) to the ground state of ^{204}Pb and for the remaining 2% by electron capture to the ground state of ^{204}Hg. Its half-life has been determined by several investigators, and a survey of the reported data until the end of 1962 shows some 14% spread if extreme values are omitted. More recent data still show an unusually high spread of 4.5%. A value of 3.774 yr for the half-life is reported, using a calorimetric method capable of very high accuracy. (UK)

40067 THE HALF LIFE OF ^{210m}Bi. Lange, Robert C.; Hagee, G. Richard (Monsanto Research Corp., Miamisburg, Ohio). J. Inorg. Nucl. Chem., 31: 2297-2301(Aug. 1969).

The half-life of ^{210m}Bi was determined to be $(3.55 \pm 0.12) \times 10^6$ yr. The determination was made by measuring the specific alpha activity of ^{210m}Bi in samples containing various amounts of ^{210m}Bi in stable ^{209}Bi. (auth) (UK)

40068 DECAY OF ^{144}Ce. Mangal, P. C.; Trehan, P. N. (Panjab Univ., Chandigarh, India). J. Phys. Soc. Jap., 27: 1-7 (July 1969).

Gamma rays in the decay of ^{144}Ce were investigated with scintillation spectrometers using $\gamma-\gamma$ coincidence, sum-peak coincidence, and $\gamma-\gamma$ angular correlation techniques. The high efficiency 3π sum-peak coincidence spectrometer study suggests that the highest excited states in ^{144}Pr and ^{144}Nd are at 166 and 2860 keV, respectively. These levels are found to de-excite by 33-133 and 2180-696 keV cascades, respectively. The $\gamma-\gamma$ coincidence study confirms the results of the sum-peak coincidence study and also yields the relative intensities of some weak gamma rays. The gamma spectra in coincidence with the 80-keV gamma ray and 35-keV Pr K x ray give K-conversion coefficients of 53 and 80 keV transitions, respectively. $\gamma-\gamma$ directional correlation measurements on the 33-41 and 53-80 keV cascades support spin 2^- and 0^- for 100-keV level and ground state of ^{144}Pr, respectively. The mixing ratio for the 53-keV transition is found to be $(99.5 \pm 0.2)\%$ M1, $(0.5 \pm 0.2)\%$ E2. (auth)

40069 STUDY OF THE SPECTRUM OF LOW-ENERGY CONVERSION ELECTRONS EMITTED BY ^{221}Fr. Leang, Chin-fan; Gautier, Francoise (Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse, Orsay, France). J. Phys. (Paris), 30: 296-300(Apr. 1969). (In French).

The conversion electron spectrum emitted by ^{221}Fr was studied by means of a $\pi\sqrt{2}\beta$ spectrometer. The multipolarity of the strong transitions was determined. Disagreement was found between I_γ and Ie^- for the 73.7- and 99.6-keV radiations, and the assumption of a double level at 99.6 keV was made. (auth)

40070 DECAY SCHEME OF ^{155}Dy. Jursik, J.; Hantowicz, V.; Zvolsky, J. (Nuclear Research Inst., Rez, Czech.). Czech. J. Phys., 19: 870-81(1969).

The simple and coincidence spectra of gamma radiation accompanying the decay of ^{155}Dy were measured with Ge(Li) and scintillation detectors. The source was obtained as a daughter product of ^{155}Ho. The intensity or the upper limit of intensity was determined for all, and the multipolarity for most, of the observed transitions. The coincidence measurements served as a basis for the introduction of new levels at 250, 1062, 1068, (1494), and 1638 keV and as a proof of the existence of the 891, 1155, 1665, and 1749 keV levels proposed earlier. (auth)

40071 DECAY SCHEME OF ^{119}I. Lagrange, Jean-Marie; Albouy, Georgette; Pautrat, Michele; Sergolle, Henri; Vanhorenbeeck, Jean (Institut de Physique Nucleaire, Orsay, France). Compt. Rend., Ser. B, 268: 1036-8(Apr. 14, 1969). (In French).

The study of gamma rays associated with the decay by β^+ emission and by electron capture of ^{119}I(13 ± 2m) permits the proposal of a partial decay scheme of this isotope. The properties of the principal levels obtained are compared with those found in the adjacent even isotopes. (tr-auth)

40072 MAGNETIC MOMENTS OF THE 114 AND 270 KeV LEVELS IN ^{149}Pm. Begzhanov, R. B.; Gaffarov, Dzh.; Salikhbaev, K. T. (Inst. of Nuclear Physics, Tashkent). JETP Lett., (USSR) (Engl. Transl.), 9: 246-8(Apr. 5, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 413-15(Apr. 5, 1969).

The g-factors of the 114- and 270-keV levels in ^{149}Pm were determined, and the $\gamma-\gamma$ angular correlations for the 536-114, 424-114, 268-270, and 268-156 keV cascades were measured. (J.W.R.)

40073 INVESTIGATION OF γ RAYS FROM NEUTRON CAPTURE ON Ba AND Pr. Becvar, F.; Liptak, J.; Urbanec, J.; Vrzal, J. (Joint Inst. for Nuclear Research, Dubna, USSR). Czech. J. Phys., 19: 899-910(1969).

The γ spectra from the capture of resonance neutrons on Ba and Pr were investigated using a high-resolution Ge(Li) spectrometer. The measurements made it possible to draw conclusion about the character of the 24.5-eV resonance in ^{135}Ba and about the low-lying levels in ^{136}Ba. Measurements concerning γ rays from the capture of resonance neutrons by ^{141}Pr made it possible to determine the character of the 85.1-eV resonance and to construct the scheme of low-lying levels in ^{142}Pr. (auth)

40074 GAMMA-RAY TRANSITIONS AND GAMMA-GAMMA ANGULAR CORRELATIONS IN ^{152}Sm. Aquilli, A.; Cesareo, R.; Giannini, M. (CNEN, Rome). Nuovo Cim., 62B: 20-35(July 11, 1969).

The gamma spectrum of 12.3y ^{152}Eu was investigated using a 30 cm^3 coaxial Ge(Li) detector. Several new gamma transitions were identified. Measurements of gamma-gamma coincidences yielded a revised level scheme of ^{152}Sm. A new level at 1294 keV was established. The spin sequences and the multipolarity mixing ratio of several gamma cascades were established using gamma-gamma angular correlation methods. The multipolarity of the $2_\beta^+ \rightarrow 2^+$ gamma transition was measured as a pure E2 one. (auth)

40075 THE K-CONVERSION COEFFICIENT OF THE 35.6 keV TRANSITION IN ^{115}In. Campbell, J. L.; Kirk, J. P. (Univ. of Guelph, Ont.). Can. J. Phys., 47: 1257-61(June 15, 1969).

The K-conversion coefficient of the 35.6-keV transition in ^{115}In was re-measured by a coincidence technique employing Ge(Li) detectors. Previous measurements differ widely among themselves, a factor of almost three existing between extreme values. The present result, 8.50 ± 0.35, which is free from many of the uncertainties present in previous work, is slightly lower than the value of 9.2 given by the self-consistent-field calculations of Hager and Seltzer. (auth) (Canada)

40076 DIRECT MEASUREMENT OF THE THERMAL NEUTRON CONVERSION RATIO OF NATURAL URANIUM. Bigham, C. B.; Durham, R. W.; Ungrin, J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 47: 1317-25(June 15, 1969).

A direct method for measuring the thermal neutron conversion ratio of natural uranium (capture in ^{238}U)/(destruction of ^{235}U) gives 0.5655 ± 0.0025 (20°C Maxwellian) in good agreement with 0.565 ± 0.009 from the separately measured cross sections. The corresponding value for the 2200 m/s absorption cross section of ^{238}U is 2.721 ± 0.016 b. The method is based on the use of a sample of ^{243}Am, which α decays to ^{239}Np, for correlating the efficiencies of the fission counter and γ counter used to measure the number of fissions and the amount of ^{239}Np produced during an irradiation of a natural uranium sample. (auth) (Canada)

40077 RELATIVE YIELDS OF STABLE TIN ISOTOPES IN NEUTRON-INDUCED FISSION. de Laeter, J. R.; Thode, H. G. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 47: 1409-14(July 1, 1969).

A tandem mass spectrometer of high sensitivity was used to measure the relative yields of the six stable isotopes of tin (^{117}Sn, ^{118}Sn, ^{119}Sn, ^{120}Sn, ^{122}Sn, and ^{124}Sn) and the long-lived isotope ^{126}Sn, produced in the thermal- and fast-neutron fission of ^{233}U and in a reactor fuel rod of natural uranium. Samples of the order of 10^{-9} g of tin were extracted and analyzed to give a range of yields in the region of symmetric fission. The results show that the mass yield curves in the region of symmetric fission covered by the stable tin isotopes are almost identical for the three irradiations. Furthermore, a smooth curve can be drawn through the yield points for the seven isotopes of tin and there is no evidence of "fine structure" or sharp depression in the curves in this region as has been predicted. (auth) (Canada)

40078 THE INFLUENCE OF SCATTERING INTERFERENCE ON RESONANCE ABSORPTION IN ^{238}U AND ^{232}Th. Neltrup, H.; Mikkelsen, J. (Research Establishment Risoe, Roskilde, Demark). J. Nucl. Energy, 22: 601-10(Oct. 1968).

Comparison is made between the resonance integral calculated by the so-called IR method and by a more exact method taking into account the scattering interference. For strongly scattering resonances up to 25% differences were found between the results of the two methods. Because of the peculiar behavior of the lowest lying resonance of ^{238}U, the overall effect on the total resonance integral is only 2 to 3% for this nuclide but, owing to the same peculiarity, differences of 5 to 10% appear when the Doppler effect is calculated by the two methods. Results for ^{232}Th show differences of 6 to 7% on the resonance integral, and a correspondingly lower error on the Doppler effect. (auth) (UK)

40079 THE CORIOLIS COUPLED $\frac{3}{2}$[651] BAND IN ^{155}Gd AND THE DECAY OF 4.9 y ^{155}Eu. Meyer, R. A.; Meadows, J. W. T. (Univ. of California, Livermore). Nucl. Phys., A132: 177-85 (1969).

Gamma-ray spectroscopy studies of isotopically separated ^{155}Eu decay were performed. The results are consistent with the assignment of the low-lying positive-parity levels belonging to the $\frac{3}{2}^+$[651] orbital which is strongly coupled to high-lying orbitals. (auth)

40080 DETERMINATION OF THE SPIN AND THE RESONANCE PARAMETERS FOR ^{107,109}Ag + n, ^{169}Tm + n, Pt + n AT 4 eV TO 830 eV. de Barros, S.; Huynh, V. D.; Julien, J.; Morgenstern, J.; Samour, C. (CEN, Saclay, France). Nucl. Phys., A131: 305-42(1969). (In French).

Experiments on silver, thulium, and platinum were performed with the Saclay linear accelerator using the time-of-flight method. Resonance parameters are given for resonances detected in the energy range 4 to 830 eV and spin value is assigned to most of the levels. The strength function dependence against neutron energy and spin value (J = 1 or 0) is discussed for these target nuclei with I = ½. The distribution of neutron reduced widths and of level spacings is given and the results are discussed. A variation of the total radiative width Γ_γ is found for ^{195}Pt + n for each spin state. This effect is interpreted from the intensity of transitions to the ground state and the first excited states. (auth)

40081 THE K-FLUORESCENCE YIELD OF Te AND THE TOTAL AND K-SHELL CONVERSION COEFFICIENTS OF THE 35.48 keV TRANSITION IN ^{125}I DECAY. Karttunen, E.; Freund, H. U.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Nucl. Phys., A131: 343-52(1969).

High-resolution Ge(Li) x-ray spectrometers were used in the singles and coincidence modes to determine the K-fluorescence yield of Te from carrier-free sources of ^{125}I. The same experiments give the total and K-shell conversion coefficients of the 35.48-keV transition in ^{125}Te. The values found for ω_K, α_T, and α_K are 0.859 ± 0.022, 13.65 ± 0.55, and 12.01 ± 0.36, respectively, assuming that the K-capture probability in ^{125}I decay is P_K = 0.797 ± 0.003. The values of α_T and α_K agree with the theoretical prediction of Hager and Seltzer for an M1 transition with less than 0.4% E2 admixture. (auth)

40082 DETERMINATION OF THE SPIN AND THE RESONANCE PARAMETERS FOR ^{197}Au + n FROM 1000 eV TO 2100 eV. Alves, R. N.; Julien, J.; Morgenstern, J.; Samour, C. (CEN, Saclay, France). Nucl. Phys., A131: 450-80(1969). (In French).

Experiments on gold were performed with the Saclay linear accelerator using the time-of-flight method. Resonance parameters are given for 69 resonances, the spin value being assigned to 57 ones: 32 J = 2, 25 J = 1. Taking into account the previous results in the energy range 10 to 1000 eV, the strength function dependence against neutron energy and spin value is discussed. The number of levels detected from 10 to 2000 eV (122 levels) permits one to study the statistical properties of the levels (mainly level spacings) and to calculate correlation coefficients ρ. A correlation between ρ (for neutron reduced widths) and $S_{0|=1}$, ρ and $S_{0|=2}$ is found. This effect is discussed. (auth)

40083 MIXING OF THE POSITIVE PARITY STATES IN ^{155}Gd. Borggreen, J.; Loevhoeiden, G.; Waddington, J. C. (Univ. of Copenhagen). Nucl. Phys., A131: 241-9(1969).

A calculation which includes Coriolis and ΔN = 2 coupling of the low-lying positive Nilsson model orbitals in ^{155}Gd is presented. A comparison is made between the calculated and experimental level positions, (d,t) pick-up cross sections, and several magnetic dipole and electric quadrupole moments. (auth)

40084 PROMPT NEUTRON YIELDS OF THE FISSION FRAGMENTS OF ^{252}Cf AS A FUNCTION OF THE CHARGE OF THE FRAGMENTS. Nifenecker, H. (CEN, Saclay, France); Ribrag, M.; Frehaut, J.; Gauriau, J. Nucl. Phys., A131: 261-6(1969).

The neutron yields of the fission fragments of ^{252}Cf were measured as a function of the charge of the fragments. No evidence for an even–odd effect was found, but a fine structure was observed in these yields. This structure is correlated with the mass-yield fine structure. (auth)

40085 PROTON POLARIZATION MEASUREMENTS NEAR ISOBARIC ANALOGUE RESONANCES IN ^{145}Eu. Fiarman, S.; Ludwig, E. J.; Michelman, L. S.; Robbins, A. B. (Rutgers-The State Univ., New Brunswick, N. J.). Nucl. Phys., A131: 267-72(1969).

Measurements of the polarization of elastically scattered protons were carried out to determine the total angular momenta of the isobaric analogs of the ground state and of the first two p-states in ^{145}Sm. They were found to be $J^\pi = 7/2^-$, $3/2^-$, and $1/2^-$, respectively. The assignment of $J^\pi = 1/2^-$ for the second l = 1 state is in disagreement with previous assignments. (auth)

40086 A STUDY OF LEVELS IN ^{153}Eu AND ^{155}Eu BY THE (^{3}He,d) REACTION. Ungrin, J. (McMaster Univ., Hamilton, Canada); Burke, D. G.; Johns, M. W.; Alford, W. P. Nucl. Phys., A132: 322-38(1969).

The (^{3}He,d) reaction has been used with targets of ^{152}Sm and ^{154}Sm to study levels in ^{153}Eu and ^{155}Eu. The 28 MeV ^{3}He beam was obtained from the University of Rochester model MP tandem Van de Graaff accelerator and the deuteron reaction products were analyzed with a broad range magnetic spectrograph. The rotational bands based on the low-lying $5/2^+$[413], $5/2^-$[532] and $3/2^+$[411] states had been previously assigned in both nuclei. The present results confirmed these assignments and, in addition, located some of the higher spin members for these bands. The previous assignments of the $1/2^+$[411] orbital at 0.636 MeV in ^{153}Eu and 0.768 MeV in ^{155}Eu have been proven conclusively to be false. (auth)

40087 QUADRUPOLE MOMENT OF ^{155}Gd 86.5 keV EXCITED STATE. Balabanov, A. E.; Delyagin, N. N.; Kornienko, E. N.; Pankratova, L. N. (Moscow State Univ.). Yadern. Fiz., 9: 1116-18(June 1969). (In Russian).

The spectrum of the 86.5-keV γ quanta Mössbauer resonant absorption by ^{155}Gd in $GdCl_3$ is measured. Well allowed hyperfine structure due to electric quadrupole interaction was observed. The ratio of the 86.5-keV excited state quadrupole moment to the ground state ^{155}Gd is found to be +2.17 ± 0.22. Positive isomeric energy shift of γ transition in $GdCl_3$ (relative to the transition energy in the Gd oxide) which is +0.66 mm/sec shows that the effective radius of ^{155}Gd nuclear charge in the 86.5-keV excited state is more than in the ground state. The electric field gradient in the region of Gd^{3+} ion nucleus in $GdCl_3$ is found to be $-9 \cdot 10^{17}$ V·cm^{-2}. (auth)

40088 ENERGY LEVELS OF ^{152}Sm AND ^{152}Gd POPULATED BY THE DECAY OF ^{152m}Eu. Multhauf, Lloyd Gilbert. University Park, Pa., Pennsylvania State Univ., 1968. 111p.
Thesis.

The decay of ^{152m}Eu was investigated to gain more information on the level structures of the nuclei ^{152}Sm and ^{152}Gd which lie in the collective model transition region. ^{152m}Eu was produced by thermal neutron bombardment of natural Eu_2O_3. Gamma rays were identified by half life comparisons and by coincidence measurements. Ge(Li) measurements were used to determine the energy values and relative intensities of most of the gamma rays observed. Gamma transitions from levels in ^{152}Sm populated by β^+ and electron capture were observed with energies (relative intensities) of 122 ± 4 (45 ± 6), 245 ± 4 (0.18 ± 0.09), 444.7 ± 2.4 (0.18 ± 0.09), 562.3 ± 1.7 (1.2 ± 0.4), 689.4 ± 2.3 (0.41 ± 0.20), 811.2 ± 2.3 (0.19 ± 0.11), 826.7 ± 2.4 (0.38 ± 0.15), 840.9 ± 0.6 (100), 870.0 ± 1.5 (0.42 ± 0.10), 962.6 ± 0.6 (84.6 ± 1.7), 995.5 ± 1.5 (0.32 ± 0.09), 1389.0 ± 0.6 (5.74 ± 0.20), 1510.8 ± 1.2 (0.070 ± 0.014), 1559.9 ± 1.2 (0.060 ± 0.016) and 1681.2 ± 1.5 (0.050 ± 0.015) keV. In addition, evidence was found for a transition of 699 (≤0.05) keV and upper limits were set on transitions of 152 (<0.010) and 548 (<0.05) keV. Transitions from levels in ^{152}Gd populated by β^- were observed with energies (relative intensities) of 271 ± 2 (0.27 ± 0.05), 343.7 ± 1.0 (16.8 ± 0.7), 700 ± 3 (0.91 ± 0.24), 970.7 ± 1.2 (4.0 ± 0.8), 1314.4 ± 0.6 (6.9 ± 0.7), 1410.7 ± 1.2 (0.32 ± 0.05) and 1756.3 ± 2.1 (0.029 ± 0.010) keV. An upper limit was set on a transition of 1141 (<0.084) keV. On the basis of these results, a decay scheme of ^{152m}Eu has been proposed by introducing levels in ^{152}Sm at 121.8, 366.5, 684.1, 811.2, 962.6, 1510.8 and 1681.2 keV, and in ^{152}Gd at 343.7, 615, 1314.4 and 1756.3 keV. Decay energies (MeV), intensities (%), and log ft values, respectively, for levels in ^{152}Sm above the first excited state are 1.23 (0.06 ± 0.05) 8.5, 0.95 (22.0 ± 0.4) 5.7 ± 0.1, 0.41 (0.72 ± 0.03), 6.5 ± 0.1 and 0.24 (0.10 ± 0.02) 6.8 ± 0.3, and for excited states of ^{152}Gd are 1.55 (1.49 ± 0.10) 8.6 ± 0.2, 0.55 (1.30 ± 0.13) 7.1 ± 0.2 and 0.12 (0.039 ± 0.006) 6.6 ± 0.2. (Disser. Abstr.)

40089 SEARCH FOR REACTION (n,α) ON RESONANCE NEUTRONS NEAR THE SHELLS N = 50 AND Z = 50. Popov, Yu. P.; Florek, M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 1163-72(June 1969). (In Russian).

First results of the search for the reaction (n,α), on resonance neutrons on the nucleus targets ^{95}Mo, ^{105}Pd, ^{122}Te, ^{129}Xe, are given. α decay from the levels of compound nuclei ^{96}Mo and ^{124}Te is detected and α widths (Γ_α) of these levels are measured. For ^{105}Pd and ^{129}Xe the upper limit for the values of Γ_α is given. The fact is discussed that the values of α widths averaged over the investigated resonances appeared to be less than those calculated on the basis of atomic nucleus statistical theory. The most violation is in ^{95}Mo. From the value of Γ_α spin and parity 0^+ are assignment to the resonances ^{123}Te with the energy 96, 235, and 275 eV. (auth)

40090 RE-INVESTIGATION OF EXCITED STATES OF ^{154}Gd. Ng, Leung-kai. Vancouver, Can., Univ. of British Columbia, 1968. Thesis.

The excited states of ^{154}Gd obtained from the decay of ^{154}Eu were investigated. Precise measurements of the energies and intensities of the gamma transitions were made, using lithium-drifted germanium detectors. A revised decay scheme is presented in which all the gamma transitional energies agree with the corresponding energy differences between levels to within 1 keV. A 1263.3-keV level is established by the presence of a gamma transition of 892.7 keV. Two other gamma transitions of energies 903.6 keV and 582.1 keV from the negative-parity levels to the 2^+ beta excited level were also discovered. The

proper locations of the 995.9 and 1004.5 keV levels in the decay scheme are confirmed by a gamma–gamma coincidence method using a germanium detector and a NaI(Tl) scintillator. The energies and intensities of the internal conversion electrons and the beta transitions were measured by an intermediate image spectrometer. Their values are quite consistent with the established decay scheme. Theoretical values of the energy levels and the branching ratios for gamma transitions were calculated, using the Asymmetric Rotator Model (J.P. Davidson's treatment). The "stiffness" parameter of the nucleus μ and its asymmetry parameter γ obtained are 0.402 and 11.52 degrees, respectively. Comparison of the experimental and theoretical energies of seven positive-parity levels gives a root-mean-square deviation of 1.5%. Three out of the four experimental branching ratios are in good agreement with the theoretical values. The monopole transition probability for the transition from the 0^+ beta excited state to the 0^+ ground state measured also agrees with the theoretical calculation. (Disser. Abstr.)

Nuclear Theory

Refer also to abstracts 39291, 39558, 39621, 39626, 39629, 39666, 39679, 39749, 39781, 39843, 39976, 39983, and 40153.

40091 (CONF-690401–, pp 492-9) NUCLEAR MODEL PROGRAMMING FOR DATA GENERATION. Yost, K. J. (Oak Ridge National Lab., Tenn.).

Reliable data on nuclear energy levels are necessary in problems concerning secondary γ-ray production cross sections as employed in shielding and gamma heating calculations. A nuclear model code used in a system for calculating γ-ray production cross sections is presented. The code generates the solution of the Schroedinger equation for a single particle in a deformed potential well within the nuclear core subject to collective excitations. As an example, the energy levels of ^{239}U were calculated by the code. (J.W.R.)

40092 (KURRI-TR-12) DEGREE OF POLARIZABILITY OF NEUTRONS IN AN ELECTRIC FIELD. Naojiro, Yasumi (comp.) (Kyoto Univ. (Japan). Research Reactor Inst.). Dec. 13, 1965. 50p. (In Japanese).

Theoretical and experimental studies on the degree of polarizability of neutrons in an electric field were surveyed. Also, abstracts of papers delivered at a symposium held at Kyoto University on February 2, 1965, on this subject are presented. The survey of experimental works covers the history of the problem and questions associated with the behavior of neutrons in an electric field. The theoretical portion examines the behavior of neutrons in electric and magnetic fields. The phenomena associated with the polarization of neutrons in an electric field discussed in the report include Compton scattering by nuclei, fourth-order effects of e-p scattering, mass differences between protons and neutrons, and forward scattering of neutrons by heavy nuclei. Separate abstracts were prepared for these two sections. (TTT)

For abstracts of individual sections see: 40031 and 40093.

40093 (KURRI-TR-12, pp 18-26) ELECTRIC AND MAGNETIC POLARIZABILITY OF NUCLEAR PARTICLES. Sugano, Reiji (Osaka City Univ. (Japan)). (In Japanese).

The theoretical aspects of the electrical and magnetic polarizability of nuclear particles are reviewed. Study of the electromagnetic structure of a nucleus yields information on the static and nonstatic structure. The static structure can be followed by measurements of the nucleus in the normal state. A nucleus placed in an electrical or magnetic field will undergo deformation and pick up electrical or magnetic polarization. Some phenomena associated with this polarization include Compton scattering by nuclei, fourth-order effects of e-p scattering, mass difference between proton and neutron, and forward scattering of neutrons by heavy nuclei. The polarization values obtained theoretically, by Compton scattering, photon-meson interactions, and the forward scattering of slow neutrons by heavy nuclei are compared. (TTT)

40094 ON THE ENERGY-DEPENDENCE OF THE MASS-OPERATOR AND THE EFFECTIVE-INTERACTION. Ethofer, S. (Technische Hochschule, Munich). Z. Phys., 225: 353-63(1969).

The energy dependence of the mass operator and the T-matrix is studied. Poles due to particle-particle (p–p) and particle-hole (p–h) collective motions are isolated. A so-called "effective-interaction" is defined. (auth)

40095 TREATMENT OF CLUSTER CHANNELS IN NUCLEAR REACTIONS ABOVE THE TWO-PARTICLE THRESHOLD. Weber, H. J.; Greiner, W. (Univ. of Virginia, Charlottesville). Z. Naturforsch., 24a: 736-46(May 1969). (ORO-2915-89).

Within the framework of the eigenchannel reaction theory above the two-particle threshold cluster channels are introduced. The eigenchannels of the S-matrix are used, i.e., continuum states which diagonalize both the S-matrix and the nuclear Hamiltonian and represent for each reaction energy a discrete set of coupled channel wave functions with a common (eigen-) phase. Especially the emission of a deuteron is discussed. It is shown that the cluster channels supplement the energy-correlated channels describing the energy partition $\epsilon_1 + \epsilon_2 = E - E_f$ and that asymptotic channel orthogonality holds. The characteristic feature of the cluster channels as compared to the energy-correlated channels is that their final-state interaction is not limited to a finite matching volume comparable to nuclear sizes. (auth)

40096 ISOSPIN SUM RULE FOR PHOTONUCLEAR REACTIONS. O'Connell, James (National Bureau of Standards, Washington, D. C.). Phys. Rev. Lett., 22: 1314-16(June 16, 1969).

A relationship is derived between the proton mean-square radius, the neutron mean-square radius, a pair correlation function in the nuclear ground state, and energy-weighted sums of the electric dipole photodisintegration cross sections to the two final isospin states. (auth)

40097 MAGNETIC DIPOLE INTERACTIONS IN DEFORMED NUCLEI PROPERTIES OF STATES WITH $K = \frac{1}{2}$. Kuliev, A. A.; Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 955-62(May 1969). (In Russian).

Spin polarization in odd deformed nuclei is considered to be due to scattering of an odd particle on the 1^+ excitations of the core. It leads to renormalization of one-particle matrix elements $\langle\sigma_z\rangle$ and $\langle\sigma_+\rangle$. Corresponding contributions to magnetic moments are taken into account by introducing the effective factors g_s^+ and g_s^- which are calculated in the theory. Possible change of the sign of the disconnection parameter of the state $\frac{1}{2}^-[510]$ is also shown. (auth)

40098 P AND CP VIOLATION AND FINE STRUCTURE OF NUCLEAR LEVELS. Likhtman, E. P.; Shirokov, Yu. M. (Mathematics Inst., Moscow). Yadern. Fiz., 9: 975-81(May 1969). (In Russian).

Various possible removals of degeneracy in the sign of the angular momentum projection on the symmetry axis of a nucleus were investigated. It appeared that this degeneracy can be removed by strong, electromagnetic, or weak P and CP noninvariant interactions. For all cases the level splitting is estimated. (auth)

40099 γ TRANSITIONS DUE TO SPACE-PARITY VIOLATION IN NUCLEAR FORCES. Gaponov, Yu. V.; Fursov, Yu. S. (Kurchatov Inst. of Atomic Energy, USSR). Yadern. Fiz., 9: 963-74 (May 1969). (In Russian).

The equation for the effective field of γ transitions induced by space–parity violation in nuclear forces is obtained in terms of the theory of finite Fermi systems. It is shown that the space–parity violation leads to necessary introduction of three types of phenomenological corrections violating the parity. The coefficient of enhancement of admixture γ transitions in spherical nuclei of ^{57}Fe, ^{59}Ni, ^{61}Cu, ^{63}Cu is calculated. (auth)

40100 A REFINEMENT OF THE 2I +1 RULE OF THE COMPOUND NUCLEAR REACTION. Takeuchi, Yuzo; Sanada, Junpei (Tokyo Univ. of Education). J. Phys. Soc. Jap., 26: 1075-7(May 1969).

In the (d,α) reaction it is recognized experimentally and theoretically that the 2I + 1 line does not pass through the origin, where I is the spin of the final nucleus. The considerations of this fact were extended to the general case. In the result, the 2I + 1 line does not pass through the origin if $I \geq f$, where f is the spin of the emitted particle. Examples of the application of this refined statement are discussed. (auth)

40101 THEORY OF THE INFLUENCE OF ENVIRONMENT ON THE ANGULAR DISTRIBUTION OF NUCLEAR RADIATION. Gabriel, Helmut (Univ. of California, Berkeley). Phys. Rev., 181: 506-21(May 10, 1969).

The effect of electronic relaxation processes on the angular correlation and on the angular distribution of radiation from oriented nuclei is investigated. The influence of the environment on the radioactive nuclei is taken into account by reducing the density operator for the total system (nucleus and surroundings mutually interacting) to a density operator for the nucleus alone. Elimination of the unobserved bath variables is performed with the help of Zwanzig's projection-operator technique. The Liouville formalism is used throughout. The (initially unspecified) properties of the environment enter the theory via second-order correlation functions, which are defined in terms of equilibrium ensemble averages of certain bath operators, like, e.g., the hyperfine-field operator.

The matrix elements of the nuclear-evolution operator (which is a superoperator in Liouville space) with respect to a complete orthonormal set of multipole operators are just the usual perturbation factors $G_{kk}{}^{qq'}$ of perturbed-angular-correlations theory. The consequent use of the multipole representation yields immediately the final formulas needed in the expression for both the angular distribution of radiation from oriented nuclei and the angular correlation function. The general theory includes relaxation processes due to magnetic and quadrupole interactions. The important case of purely magnetic interactions is discussed in more detail. Specialization to relaxation caused by randomly fluctuating fields yields a formula which contains both the Abragam–Pound result for time-fluctuating quadrupole interaction and Micha's extension to randomly time-varying magnetic fields in multidomain ferromagnets. Exact high-temperature solutions are presented for single crystals in a static magnetic field and with magnetic-type relaxation processes (axially symmetric case). For nuclei with spin I = 1, the extension to arbitrary temperatures has been considered. The application of the present theory to the problem of multipole relaxation (which arises, e.g., in spin-lattice relaxation measurements with NMR/ON technique) is discussed. (auth)

40102 INVESTIGATION OF UNAMBIGUITY OF PARAMETERS IN THE PHASE SHIFT ANALYSIS. Gonchar, V. Yu. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 9: 987-96(May 1969). (In Russian).

A problem to describe charged-particle interactions with nuclei under strong absorption using parametrized phase-shift analysis is considered. A series of programs was developed to search automatically on the computer BSM-3m for five optimal parameters of the scattering matrix providing the best agreement with the experimental data as well as the program for investigation of unambiguity of parameters obtained in the automatic search. Results of application of the phase-shift analysis to the study of elastic scattering of α particles with energy about 40 MeV on the nuclei ^{24}Mg, ^{48}Ca, and ^{88}Sr are discussed. It is shown that unlike the optical model, the application of the phase-shift analyses makes it possible to describe unambiguously charged particles interaction under strong absorption. (auth)

40103 Z DEPENDENCE OF RADIATIVE CORRECTIONS TO β DECAY. Beg, M.A.B. (Rockefeller Univ., New York); Bernstein, J.; Sirlin, A. Phys. Rev. Lett., 23: 270-3(Aug. 4, 1969).

It is shown that to first order in α, and with neglect of effects which vanish in the limit of zero lepton momenta, the theoretical ft value in $0^+ \rightarrow 0^+$ Fermi transitions is independent of Z. The only model-dependent feature of this argument is in the treatment of effects induced by the axial current. It is further shown that in higher order radiative corrections the power of Z cannot exceed the power of α; the leading term in the radiative correction to the ft value is therefore of order $Z^2\alpha^2$. (auth)

40104 ABSORPTION OF K^- MESONS IN NUCLEAR SURFACES. Bloom, S. D.; Johnson, M. H.; Teller, E. (Univ. of California, Davis). Phys. Rev. Lett., 23: 28-30(July 7, 1969).

Preliminary results are presented of an analysis of the experimental data pertaining to K^- capture on complex nuclei. The theory takes explicit account of the Y_1^* resonance as well as the change in the neutron-to-proton density ratio in going from the nuclear core to the region outside the normal nuclear radius. Results are obtained which are in rough accord with experiment, and it is concluded that the role of the Y_1^* cannot be ignored in deducing properties of the nuclear surface. (auth)

40105 MAGNETIC MOMENTS AND MAGNETIC DIPOLE TRANSITIONS IN DEFORMED NUCLEI. Krutov, V. A.; Zackrevskii, N. V. (Leningrad State Univ.). J. Phys., A (London), 2: 456-62(July 1969).

The magnetic moments of the lowest rotational states of even–even nuclei and the probabilities of magnetic dipole transitions between these states are calculated on the basis of the model suggested by Krutov in 1968, the non-axiality of the nuclear equilibrium shape and the difference between the mass and charge distributions being taken into account. The results of calculations are compared with the available experimental results, the agreement being reasonably satisfactory. (auth) (UK)

40106 ON THE EVALUATION OF THE MOMENTS OF INERTIA OF NUCLEI. Urbano, J. N. (Univ. of Coimbra, Portugal). J. Phys., A (London), 2: 471-2(July 1969).

A re-interpretation of previous numerical results based upon the Peieris–Urbano (1968) method shows a remarkable agreement of the calculated moment of inertia of ^{28}Si with the experimental value. In the calculations it was assumed that the true ground-state binding energy is known. Since there is a possible objection against such a procedure, an alternative way of performing calculations is proposed. (auth) (UK)

40107 DEPENDENCE OF THE r.m.s. NUCLEAR RADIUS ON THE DEFORMATION PARAMETERS. Cusson, R. Y. (Atomic Energy of Canada, Ltd., Chalk River, Ont.); Castel, B. Can. J. Phys., 47: 1189-93(June 1, 1969).

The concept of "nuclear compressibility under deformation," introduced by Fradkin and others in their experimental studies of isotope shifts, is analyzed. It is shown that in the harmonic-oscillator model Fradkin's compressibility parameter ξ can occur in a natural way. Theoretical estimates of ξ are obtained, using spherical and deformed oscillator models, as $\xi = -5/4\pi$ and $-5/16\pi$, respectively. They bracket the experimental value $\xi \cong -0.2 \cong -5/8\pi$. Possible improvements of these estimates are discussed. (auth) (Canada)

40108 THE ISOBARIC-SPIN POTENTIAL IN HEAVY DEFORMED NUCLEI. Krutov, V. A.; Savushkin, L. N. (Leningrad State Univ.). J. Phys., A (London), 2: 463-5(July 1969).

A simple method for deriving the isobaric-spin potential is suggested. It is based on using the proton and neutron occupation numbers in the framework of the single-particle level scheme. This technique is applied to the calculation of the symmetry energy parameter V_1 for thirty-five heavy deformed nuclei. The average value of V_1 is found to be 156 MeV, the deviations from this value for particular nuclei being small (for twenty-nine nuclei they do not exceed 10% of the average value, and for the rest they are less than 15%). (auth) (UK)

40109 A DOUBLE-SCATTERING MODEL FOR THE ^{6}Li(^{16}O,d)^{20}Ne REACTION. Cheon, Il-T.; Sen Gupta, H. M. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett., 29B: 268-9(May 26, 1969).

A double-scattering model within the framework of the alpha-clusters in nuclei had been proposed for the ^{6}Li(^{16}O,d)^{20}Ne reaction; it is possible thereby to account for the observed forward peak in the angular distributions. (auth)

40110 MICROSCOPIC DESCRIPTION OF THE ABSORPTION OF BOUND π-MESONS. Chung, K. (Univ., Frankfurt am Main); Danos, M.; Huber, M. G. Phys. Lett., 29B: 265-7(May 26, 1969).

The absorption rates of bound 1s and 2p pions in ^{16}O have been calculated in the shell model modified by a two-body correlation factor. It turns out that both the correlations and the shell model aspects are essential to explain both 1s and 2p absorption rates in a consistent picture. Furthermore, the spectra of the emitted nucleons contain useful information about the details of the correlation factor. (auth)

40111 STRUCTURE OF ^{141}Pr. Wildenthal, B. H. (Texas A and M Univ., College Station). Phys. Lett., 29B: 274-6 (May 26, 1969).

The structure of ^{141}Pr as revealed by recent experiments is compared to the predictions of a shell model calculation for this nucleus. (auth)

40112 THE INFLUENCE OF FRACTIONAL PARENTAGE STRUCTURE OF GROUND STATE ON THE PHOTODISINTEGRATION OF ^{12}C NUCLEUS. Goncharova, N. G.; Yudin, N. P. (Moscow State Univ). Phys. Lett., 29B: 272-3(May 26, 1969).

The dipole resonance in ^{12}C is calculated with wave functions in the intermediate coupling approximation. (auth)

40113 POSITIVE PARITY STATES IN ^{16}O. Kluge, G.; Manakos, P. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 29B: 277-9(May 26, 1969).

The positive parity states in ^{16}O are calculated in the shell model with 2ph and 4ph excitations free from spurious components. The energies, B(E2) values 0-0 transition matrix elements agree fairly well with experiments. (auth)

40114 γ-VIBRATION OF THE UNIFORMLY CHARGED ELLIPSOIDAL DROP. Zielinska-Pfabe, Malgorzata (Inst. of Nuclear Research, Warsaw). Phys. Lett., 29B: 280-1(May 26, 1969).

The γ-vibrational characteristics of the fissioning nucleus in equilibrium and the saddle point are calculated with the use of the hydrodynamical model. The results show that the stiffness with respect to the non-axial vibration increases with the deformation of the nucleus. (auth)

40115 GROUP-THEORETICAL DECOMPOSITION OF EFFECTIVE INTERACTIONS IN THE sd-SHELL. Pluhar, Z. (Charles Univ., Prague). Phys. Lett., 29B: 293-5(May 26, 1969).

The Kuo effective interactions are decomposed into irreducible parts classified according to the Elliott classification scheme and properties of obtained decompositions are discussed. (auth)

40116 ISOSCALAR TRANSITION RATES FROM THE (α,α') REACTION. Bernstein, A. M. (Massachusetts Inst. of Tech.,

Cambridge). Contract AT(30-1)-2098. Phys. Lett., 29B: 332-4 (June 9, 1969).

The magnitude of the differential cross section for the (α,α') reaction is shown to be proportional to the square of the matrix element of a microscopic, one body, isoscalar multipole transition operator. This is tested experimentally by observing the experimental equality of isoscalar and EM transition rates for $\Delta T = 0$ transitions in $T = 0$ nuclei. A combination of isoscalar and EM transition rates gives information about the neutron and proton contributions to nuclear excitation rates. (auth)

40117 A COMPARISON OF ELECTROMAGNETIC AND ISOSCALAR TRANISTION RATES IN NUCLEI. Bernstein, A. M. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Lett., 29B: 335-7(June 9, 1969).

Electromagnetic and isoscalar transition rates are compared for the lowest 2^+ and 3^- states of $N > Z$ even–even nuclei. It is found that the relative contributions of neutrons and protons to the excitation matrix elements are approximately in the ratio N/Z, seemingly independent of shell structure. This result is natural for collective, but not for microscopic, models. (auth)

40118 THE VALIDITY OF SOFT PION THEOREMS FOR RADIATIVE PION ABSORPTION IN NUCLEI. Fulcher, L. P. (Univ. of Virginia, Charlottesville); Guy, R.; Eisenberg, J. M.; Pietschmamm, H. Phys. Lett., 29B: 338-40(June 9, 1969).

The Kroll–Ruderman theorem, as derived from the hypotheses of partially conserved axial-vector currents and current commutators, must be modified when real pions rather than soft pions are considered. Such corrections are evaluated for radiative pion absorption in nuclei. (auth)

40119 ON Y_2–Y_4 NUCLEAR SHAPE CORRELATIONS. Castel, B. (Queen's Univ., Kingston, Can.); Parikh, J. C. Phys. Lett., 29B: 341-2(June 9, 1969).

The correlation between Y_2 and Y_4 nuclear shapes is examined using a Hartree–Fock calculation. The hexadecapole moment is seen to change sign through a region of Y_2 deformation, in agreement with recent experimental results as well as a previous theoretical conjecture. The importance of space correlations in understanding the structure of ^{24}Mg and ^{28}Mg is outlined. (auth)

40120 TRANSFER REACTION OF HEAVY ION IN THE DIFFRACTION MODEL. Suzuki, Takehiko (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 41: 695-704(Mar. 1969).

Transfer of two neutrons between heavy ions at the incident energy near the Coulomb barrier is investigated in terms of the semiclassical strong absorption model. The nuclear radius parameter obtained from analysis of this process is in moderately good agreement with the best-fit values in the cutoff model for elastic scattering of heavy ions. This parameter is found to be smaller than those deduced from many classical analyses of single nucleon transfer reactions at energies well above the barrier. This discrepancy is discussed. (auth)

40121 INTERACTION BETWEEN CLUSTERS AND PAULI PRINCIPLE. Saito, Sakae (Hokkaido Univ., Sapporo. Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 705-22(Mar. 1969).

The Pauli principle characterizes the relative state between clusters in the overlapping region. A theory to clarify the role of the Pauli principle in the interaction between clusters in a simple way is proposed. The equation of motion for the relative state, obtained as a consequence of the total antisymmetrization, excludes naturally the states forbidden by the Pauli principle. The relative state is mainly determined by the orthogonality condition to the forbidden states for the inside and by a local potential for the outside. It is shown that both the characteristic inner oscillation and the almost energy-independent nodes of the relative wave function, which appear in the $\alpha-\alpha$ scattering and are interpreted as the origin of the effective repulsive core, are produced by this orthogonality condition. The features of the $\alpha-\alpha$ scattering are clarified on the basis of the theory proposed. (auth)

40122 ANALYSIS OF PROTON–NUCLEUS FORWARD SCATTERING. Hasebe, Katsuya; Mori, Terunori (Aichi Univ., Toyohashi, Japan). Progr. Theor. Phys. (Kyoto), 41: 841-3(Mar. 1969).

Phenomenological relations between the existence of resonances and energy dependence of the diffraction peak in elementary-particle scattering at high energies were studied previously [Progr. Theor. Phys. (Kyoto), 38: 202(1968)]. These relations are applied to forward elastic scattering of protons by nuclei, specifically lithium, beryllium, and carbon at 20 MeV to 1 GeV. It is found that the relations hold in this case. It is suggested that common features exist in both elementary-particle interactions and proton–nucleus interactions. (L.T.W.)

40123 AVERAGE NUCLEAR PROPERTIES. Myers, William Don. Berkeley, Calif., Univ. of California, 1968. 159p.

Thesis.

A generalized treatment of average nuclear properties is presented. The theory is developed on two levels: First a refinement of the Liquid Drop Model, called the Droplet Model, is presented. The degrees of freedom in this model, in addition to the usual shape variables, are variables specifying deviations from uniformity of the neutron and proton densities. The form of the Hamiltonian defining the Droplet Model, of which only the potential energy part is considered, is derived by expanding the volume, surface and Coulomb energies in Taylor series around the standard Liquid Drop Model values. Such an expansion, designed to retain all terms in the total energy up to order $A^{\frac{1}{3}}$, $I^2A^{\frac{1}{3}}$, and I^4A (where $I = (N-Z)/A$), turns out to contain ten parameters. Four of these are the standard adjustable parameters of the Liquid Drop Model and six are new coefficients specifying various properties of nuclear systems. (Nuclear compressibility and the surface symmetry coefficient are two examples.) Minimizing the Droplet Model potential energy with respect to density variations, leads to equations, in closed form, specifying the separate neutron and proton radii, the density non-uniformities and to a refined Droplet Model Mass Formula. The second level at which average nuclear properties are treated is based on assuming a concrete model of a two component saturating system, consisting of neutrons and protons, interacting by velocity dependent Yukawa forces (and Coulomb forces). When this model is treated in the Thomas-Fermi approximation a pair of coupled integral equations results, which can be used as the basis of a self-contained model of all average static nuclear properties. The solutions of these equations are discussed in the idealized situations of nuclear matter and semi-infinite nuclear matter, and for finite nuclei both with and without Coulomb energy. One result of these studies is the determination of the values of the six new Droplet Model parameters. Other results have to do with the nuclear density distributions, and the binding energies. The applications of the Droplet Model and Thomas-Fermi Model that are discussed include predictions concerning neutron and proton radii (in particular the presence of a neutron skin), the isotope effect in proton radii, the compression of the nucleus by the surface tension and the dilatation by the Coulomb energy, and the central depression in the densities caused by the Coulomb repulsion. Calculations are made for the surface curvature correction, for the surface symmetry energy, for a modification to the volume symmetry energy for large neutron excess, and a revised estimate is made for the value of the symmetry energy of nuclear matter. Also treated is the question of whether or not neutron matter is bound, and some discussion is given of the spatial distribution, the energy dependence and the composition dependence to be expected for nuclear optical model potentials on the basis of the statistical methods used. (Diss. Abstr.)

40124 COMPARISON OF SOME APPROXIMATIONS USED IN DIRECT NUCLEAR REACTIONS. Gignoux, C. (Institut des Sciences Nucleaires, Grenoble, France). J. Phys. (Paris), 30: 289-96(Apr. 1969). (In French).

The Faddeev–Lovelace equations were resolved numerically in order to test the validity of the T matrix approximation and of the DWBA for exchange reactions, as well as the validity of the sudden approximation for stripping reactions. (auth)

40125 OSCILLATORY FUNCTIONS AND NUCLEAR MATTER. Filippov, G. F. (Inst. of Theoretical Physics, Kiev). Ukr. Fiz. Zh., 14: 553-65(Apr. 1969). (In Russian).

Problems are presented concerning the technique of operation with basic wave functions of the system of N nucleons constructed from the wave functions of separate nucleons in a central-symmetrical oscillatory field. Particular attention is paid to calculating different physical values. The oscillatory wave functions are used for calculating binding energy of nuclear matter. As a result, a sufficient condition can be formulated on a pair potential. On satisfying this condition nuclear matter appears to be in a constricted state. (auth)

40126 CONTRIBUTION TO THE THEORY OF NUCLEAR REACTIONS THROUGH ISOBARIC ANALOG STATES. Kolomiets, V. M.; Tsekhmistrenko, Yu. V. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 14: 597-607(Apr. 1969). (In Russian).

The theory is developed of resonance nuclear reactions with protons (p,p), (p,γ), (p,n) on heavy nuclei ($N-Z \gg 1$). The phenomenological potential of Lanes $v_l \sim tT$ is not used in the theory. The formulas are obtained for calculating nucleon and radiation widths of the analog states. The effect is discussed of nonconserving isotopic spin, residual Coulomb interaction, and arising fine structure of resonances being taken into account. (auth)

40127 DETERMINATION OF THE DEGREE OF OVERLAPPING OF α SUBSTRUCTURES IN ^{12}C BY THE STUDY OF THE REACTION $^{12}C(t,\alpha)^{11}B$. Nahabetian, Robert; Joseph, Jacques;

Elbaz, Edgard; Lafoucriere, Joseph (Univ., Lyon). Compt. Rend., Ser. B, 268: 1109-12(Apr. 21, 1969). (In French).

The use of the preferential substructure model allows the calculation of reduced widths for the reaction $^{12}C(t,\alpha)^{11}B$. The determination of the interaction radii by the adjustment of the theoretical and differential cross section curves defines the degree of overlapping for various substructures or clusters composing the ^{12}C nucleus. (tr-auth)

40128 MODIFICATION OF THE SERBER FORCES AND THE NUCLEAR MATTER COLLAPSE PROBLEM. Dzhibuti, R. I.; Mamasakhlisov, V. I. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 54: No. 1, 57-9(Apr. 1969). (In Russian).

A new separable potential of the nucleon–nucleonic interaction is obtained by means of the Serber forces modification. It is shown that the new potential gives correct values of the energy per particle of nuclear matter and the ground state energy of several finite nuclei. (auth)

40129 COLLECTIVE QUADRUPOLE STATES OF EVEN NUCLEI. Suarez, J. F. (Comision Nacional de Energia Atomica, Buenos Aires). Nuovo Cim., 62B: 109-20(July 11, 1969).

Surface vibrations of even nuclei with quadrupole deformation are taken into account to compute the contribution of rotations to nuclear spectra. The complete range $0° \leq \gamma_0 \leq 30°$ is covered with the same solution for the Hamiltonian equation. The agreement with the small-vibrations hypothesis is better than that obtained with previous models. (auth)

40130 SCHEMATIC FORCES AND NUMBER-CONSERVING APPROACH TO SPHERICAL NUCLEI. Boldrighini, C.; Tesei, A. (Univ., Rome). Nuovo Cim., 62B: 178-94(July 11, 1969).

In the frame of a method originally proposed by Jean, an exact expression is found for the eigenvalues of some residual interaction Hamiltonians in the degenerate model of spherical nuclei. The limits of validity of the isopairing force and other similar schematic forces are examined and extended. For the nondegenerate model, in a particular case (small energy gap between the various shells) a simple approximate formula for the eigenvalues of the pairing Hamiltonian is derived. (auth)

40131 SPIN–SPIN AND SPIN–ORBIT INTERACTIONS IN THE NUCLEAR OPTICAL MODEL. Kharchenko, V. F.; Chesnokova, V. D. (Inst. of Physics, Kiev. Kiev State Univ.). Ukr. Fiz. Zh., 14: 651-64(Apr. 1969). (In Russian).

The formalism of the optical model involving all the possible types of spin–spin and spin–orbit interactions is developed. Using the method of partial waves, general expressions are obtained for cross section and polarization in the elastic scattering of particles with arbitrary spin by nuclei, the latter spins being taken into account. As an illustration numerical calculations of the cross section and polarization for 7-MeV neutrons scattered by ^{31}P and ^{89}Y nuclei with spin $\frac{1}{2}$ are made to investigate the effect of spin–spin interaction. (auth)

40132 HARTREE–FOCK THEORY FOR LIGHT α-NUCLEI. Wadia, Wahby (Atomic Energy Establishment, Cairo). Z. Phys., 224: 425-31(1969).

The Hartree–Fock theory is discussed and formulated assuming that the Hartree–Fock Hamiltonian has the symmetries adopted in the α-particle model. Preliminary investigation of the nature of the solutions is carried out for infinitely long- and short-range central forces. (auth)

40133 ON THE THEORY OF ROTATION OF NON-AXIAL NUCLEI. Krutov, V. A.; Zackrevskii, N. V. (Leningrad State Univ.). J. Phys., A (London), 2: 448-55(July 1969).

Rotation of nonaxial nuclei is considered in the framework of the model suggested by Krutov in 1968. The parameters of the total deformation and nonaxiality are calculated for a number of deformed even–even nuclei with $A \geq 150$ on the basis of the energies of the first 2^+ rotational states. The E2 transition probability ratios are calculated for transitions between low-lying rotational levels in the nonaxial nuclei. These ratios are compared with experiment (agreement is satisfactory) and with the Davydov–Chaban (1960) and Davydov–Filippov (1958) model predictions. (auth)

40134 OCTUPOLE DEFORMATIONS IN THE 2s-1d SHELL. Castel, B. (Queen's Univ., Kingston, Ont.); Svenne, J. P. Can. J. Phys., 47: 1393-5(July 1, 1969).

The dependence of the nuclear energy on the deformation parameters of order two and three is investigated for some s-d shell nuclei. A Hartree–Fock technique is used to calculate the stiffness parameters for quadrupole and octupole deformations. The nuclei most soft under quadrupole and octupole deformations are seen to be ^{30}Si and ^{36}Ar, respectively. The reduced E3 transition rates are calculated and are compared with available experimental results. (auth) (Canada)

40135 STRUCTURE OF ATOMIC NUCLEI. Suessmann, Georg (Univ., Munich). pp 45-73 of Atome, Kerne, Elementarteilchen. Suessmann, Georg; Fiebiger, Nikolaus (eds.). Frankfurt am Main, Umschau Verlag, 1968. (In German).

The constituents of the nucleus are characterized, and the structure of the nucleons is discussed. The nuclear forces holding the nucleons in the nucleus are considered. The nuclear models—the drop, shell, pair force, substructure, optical, and statistical models—were described. (J.S.R.)

40136 NUCLEAR FISSION. Fiebiger, Nikolaus (Univ., Erlangen, Ger.). pp 75-96 of Atome, Kerne, Elementarteilchen. Suessmann, Georg; Fiebiger, Nikolaus (eds.). Frankfurt am Main, Umschau Verlag, 1968. (In German).

The question of when it is energetically possible for a nucleus to fission is considered. The magnitudes on which fission probability depends are analyzed. The models designed to represent the mechanism of the fission process are described. (J.S.R.)

40137 THE MASS SYSTEMATICS OF THE 2s-1d SHELL ANALYSED BY THE AVERAGE ENERGY METHOD. Ichimura, Munetake (Atomic Energy Research Inst., Tokyo). Nucl. Phys., A131: 398-416(1969).

It is well known that the average two-body interaction energy of all states with the same seniority, reduced isospin, and isospin in the j^n configuration can easily be calculated by a device of group theory, which is called the average energy method. This method is generalized in the direction that it is applicable to an m-body operator (m is an arbitrary number) and to any type of coupling schemes specified by the group chains as well as the seniority-reduced-isospin scheme. The mass systematics of the 2s-1d shell is analyzed by the least mean square method, in terms of the formulas derived by the generalized average energy method for the jj- and the LS-coupling pairing scheme. All of the sd-shell nuclei cannot be systematized by only one coupling scheme. Very good agreement with the experimental values is obtained in the region $14-16 \leqq N, Z \leqq 20$ by the jj-coupling pairing scheme in the $(s_{\frac{1}{2}}d_{\frac{5}{2}})^n$ or $(d_{\frac{5}{2}})^n$ configuration, while outside of this region, only the even–odd nuclei can be systematized by the simple formula for the LS- or the jj-coupling pairing scheme in the $(d_{\frac{3}{2}}s_{\frac{1}{2}}d_{\frac{5}{2}})^n$ configuration. It is conjectured from this fact that the doubly even and the even–odd nuclei in the first half of the sd-shell obey the different coupling schemes. (auth)

40138 ELASTIC ELECTRON SCATTERING FROM NUCLEAR MAGNETIC MOMENTS IN ^9Be AND PROJECTED HARTREE–FOCK WAVE FUNCTIONS. Bouten, M. (International Centre for Theoretical Physics, Trieste, Italy. SCK–CEN, Mol, Belgium); Bouten, M.-C.; Depuydt, H. Nucl. Phys., A131: 385-92(1969).

General formulas are given for calculating magnetic form factors with projected Hartree–Fock functions. As an application, the magnetic form factor of ^9Be is calculated. It is found that the octupole part of the magnetic form factor depends on the deformation of the Hartree–Fock field. The agreement with experiment is satisfactory. (auth)

40139 PROPERTIES OF THE DISCRETE AND CONTINUOUS SPECTRA OF THE RADIAL DIRAC EQUATION. Sakhnovich, L. A. (Odessa Electrical Communications Inst.). Dokl. Akad. Nauk SSSR, 185: 61-4(1969). (In Russian).

The radial Dirac equation is written as a differential equation. The conditions for solution of this equation involve a regular nuclear potential which requires a real value of the potential at approach distances $R > 0$. The analytical properties of an intermediate function are studied in detail. The concepts of quantum defects of the continuous and discrete Dirac spectra are introduced. The existence of quantum defects is proved, and formulas are derived for calculating the quantum defects. (TTT)

40140 K^- MESON CAPTURE BY NUCLEI AND THE EXISTENCE OF A NEUTRON HALO IN HEAVY NUCLEI. Burhop, E. H. S. (Univ. Coll., London); Davis, D. H.; Sacton, J.; Schorochoff, G. Nucl. Phys., A132: 625-8(1969).

The evidence concerning the region of the nucleus in which the capture of K^- mesons in K mesonic atoms predominantly occurs is re-examined in the light of a recent criticism. It is concluded that capture in the extreme peripheral region where the nuclear density is of the order of 5% of the central density and the existence of a neutron halo in heavy nuclei remain the most probable interpretation of the available data. (auth)

40141 COUPLED-CHANNEL CALCULATIONS OF THE GIANT DIPOLE RESONANCE IN THE ONE-PARTICLE-ONE-HOLE CONTINUUM APPROXIMATION. I. ^{12}C AND ^{40}Ca. Marangoni, Marina (Centro di Calcolo, Bologna); Saruis, Anna Maria. Nucl. Phys., A132: 649-72(1969).

The dipole photoreaction cross sections of ^{12}C and ^{40}Ca have

been calculated in the frame of the 1p-1h continuum approximation by means of the coupled-channel method. The results are compared with those obtained from the standard shell-model calculations and with the experimental data. (auth)

40142 THREE-BODY POTENTIAL MATRIX ELEMENTS FOR THE TRITON. Pask, Colin (Univ. of New South Wales, Kensington). Nucl. Phys., A132: 673-89(1969).

Using the representation of three-body potentials in terms of irreducible tensor operators given in an earlier paper, matrix elements for the complete set of external functions defined by Derrick and Blatt in their classification of the triton wave function are found. Some properties of the matrices are established. Care is taken to check the calculations at every stage and special relations are derived for that purpose. (auth)

40143 PAIRING VIBRATIONS OF NORMAL SYSTEMS. Ripka, G.; Padjen, R. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nucl. Phys., A132: 489-511(1969).

The theory of pairing vibrations is derived by three different methods, e.g., time-dependent Hartree–Bogolyubov theory, the diagrammatic perturbation theory, and the generator coordinate method. Each of these approaches stresses different physical properties of pairing vibrations. Ground state correlations induced by pairing vibrations are treated as well as the interdependence between pairing and normal RPA vibrations. (auth)

40144 STUDY OF DEUTERON STRIPPING REACTION BY COUPLED CHANNEL THEORY. I. VARIATIONAL FORMULATION AND DISCUSSION ON BASIC EQUATIONS. Ohmura, Takashi (Nihon Univ., Tokyo); Imanishi, Bunryu; Ichimura, Munetake; Kawai, Mitsuji. Progr. Theor. Phys. (Kyoto), 41: 391-418(Feb. 1969).

Close coupling equations for the rearrangement reaction A + d → B + p are derived from a variational principle for reaction amplitude assuming the usual stripping mechanism. The sum of the wave functions of the deuteron and proton channels is used as a trial function. An exact and simple expression for the error introduced into the reaction amplitude is also derived by applying the theory of finite variations. The variational principle is not affected by the existence of ambiguity in defining the proton and deuteron wave functions of relative motion, which should be carefully considered for rearrangement reaction because of the "non-orthogonality" or channels. The origin of this non-uniqueness and the induced ambiguity in the optical potentials are discussed in connection with the relation between the present method and the method of the projection operators. The interaction kernel consists of two parts, one coming from the usual $V_{sp} + V_{pA} - U_{pB}$ term and the other due to the non-orthogonality of the initial and final channel wave functions. It is shown that DWBA is obtained only if the whole interaction kernel (not $V_{sp} + V_{pA} - U_{pB}$ alone) is considered as perturbation. The relation between the present method and the methods of projection operators is discussed. (auth)

40145 IDENTIFICATION OF β-VIBRATIONAL STATES IN DEFORMED NUCLEI. Sood, P. C. (Tokyo Univ. Oak Ridge National Lab., Tenn. Univ. of Alberta, Edmonton). Progr. Theor. Phys. (Kyoto), 41: 574-6(Feb. 1969).

A simple criterion for the identification of β-vibrational states in deformed nuclei is given. The method differentiates between the pairing and β-vibrations in nuclei with more than one O^+ excited states. (J.W.R.)

40146 NUCLEAR STRUCTURE. VOLUME I. SINGLE-PARTICLE MOTION. Bohr, Aage; Mottelson, Ben R. New York, W. A. Benjamin, Inc., 1969. 482p. $25.00.

Volume I is devoted to single-particle motion. Chapters on symmetries and conservation laws, independent-particle motion, and single-particle configurations are included. Appendices are provided which study in detail the various formalisms used. (J.W.R.)

40147 STATISTICAL THEORY OF NUCLEAR FISSION. Fong, Peter. Documents on Modern Physics. New York, Gordon and Breach, Science Publishers, Inc., 1969. 227p. $19.50 cloth; $9.50 paper.

The author's collected papers, his dissertation, and a master's thesis written under his tutelage, all of which are on the statistical theory of fission, are included. (J.W.R.)

40148 SIMPLE METHOD FOR INVESTIGATING THE PARENTAGE OF STATES USING TWO-NUCLEON TRANSFER REACTIONS. Hardy, J. C.; Brunnader, H.; Cerny, Joseph (Univ. of California, Berkeley). Phys. Rev. Lett., 22: 1439-43(June 30, 1969).

A promising method for investigating the parentage of nuclear states is described. It involves the simultaneous observation of (p,t) and (p,^{3}He) reactions on 0^+ (T > 0) targets producing analog final states with the same isospin as the target. Experimental results for $20 \leq A \leq 36$ (T = 1) reveal a number of states with apparently very simple parentage for which j^2 "paired" pickup predominates. (auth)

40149 INELASTIC SCATTERING OF NEUTRONS. I. QUASI-COMPOUND NUCLEUS THEORY. Bertram, W. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aust. J. Phys., 22: 135-43(Apr. 1969).

The Feynman propagator formalism is used to derive a theory for the inelastic scattering of neutrons, in which the scattering amplitude contains direct and compound nucleus-like parts. The relation between this and the Feynman-diagram method of Shapiro is established. Difficulties associated with the evaluation of the scattering amplitudes are discussed. In its present form the theory cannot be used to calculate cross sections owing to the large number of parameters in the expressions. (auth) (Australia)

40150 MULTICHANNEL CANCELLATION EFFECTS IN ANALOG ASYMMETRY AND BROADENING. Lane, A. M. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 29B: 263-4(May 26, 1969).

It is shown that the observed large asymmetry and small spreading width of analogs do not necessarily require the customary (illicit) single-channel approach, but are consistent with a multi-channel description. (auth)

40151 AN APPROXIMATE CONNECTION BETWEEN THE OSCILLATOR BASIS "SUSSEX MATRIX ELEMENTS" AND THE CORRESPONDING ON- AND OFF-THE-ENERGY SHELL PLANE WAVE MATRIX ELEMENTS. Mavromatis, H. A.; Singh, B. (American Univ. of Beirut, Lebanon). Phys. Lett., 29B: 282-4 (May 26, 1969).

An approximate connection between the oscillator basis "Sussex matrix elements" and the corresponding on- and off-the-energy shell plane wave matrix elements is indicated. This approach is compared with the Kallio approximation. Agreement between the two methods is very good. (auth)

40152 OPTICAL POTENTIAL FOR DEUTERON. Satpathy, R. K. (Saha Inst. of Nuclear Physics, Calcutta); Samaddar, S. K.; Mukherjee, Suprokash. Nucl. Phys., A132: 276-86(1969).

An analytical expression for the deuteron optical potential is used to calculate the differential cross section for the elastic scattering of the deuteron from various targets. Comparison with experimental results indicates that a good fit to the experimental results cannot be obtained if the well-depth of the imaginary part of the nucleon optical well is not allowed to vary with energy. (auth)

40153 INELASTIC NUCLEAR ELECTRON SCATTERING IN THE INDEPENDENT PARTICLE MODEL. De Forest, Taber Jr. (Massachusetts Inst. of Tech., Cambridge. Laboratoire de l'Accelerateur Lineaire, Orsay, France). Nucl. Phys., A132: 305-21 (1969).

The quasi-elastic model of nuclear electroexcitation has been generalized to include the effects of binding and the distortion of the wave function of the emitted nucleon by an energy-dependent nuclear potential. The model predicts cross sections which are in good agreement with the inelastic spectra observed in ^{12}C experiments. For ^{16}O, however, the experimental cross sections are larger than predicted especially for small energy transfers. This may be due to correlations associated with multiparticle-hole excitations which are not included in the model. The inclusion of the Perey effect, which is necessary to guarantee the usual electron scattering sum rules, was found to be very important, reducing the cross sections by 30 to 40%. (auth)

40154 COUPLED EQUATIONS AND EFFECTIVE POTENTIALS FOR DIRECT PROCESSES. Hahn, Yukap (Univ. of Connecticut, Storrs). Nucl. Phys., A132: 353-68(1969).

The properties of the effective potential matrix which appears in an exact set of coupled equations are examined for the direct rearrangement collisions, especially the non-locality which arises due to inelastic channels and particle rearrangement. A symmetric parametrization of the effective potential is introduced such that the inelastic distortions on the elastic and pickup channels can be treated simultaneously within the same approximation, thus reducing the number of adjustable parameters in the theory. The usual distorted wave method may also be modified for elastic amplitudes, and this extension leads to additional constraints on the optical model potentials. Possibility of estimating the inelastic channel propagators from the shell-model calculation is explored. (auth)

40155 HIGH-ENERGY INTERNAL CONVERSION COEFFICIENTS. Dragoun, O. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A132: 374-84(1969).

The K-shell internal conversion coefficients were calculated for every fifth value of the atomic number Z from Z = 30 to Z = 100 for lowest four electric and magnetic transition multipoles. The finite nuclear size effect and screening by atomic electrons were considered precisely in the energy region from 6 to 9.5 mc^2 and approximately for energies from 12 to 20 mc^2. The K/(L + M) conversion coefficient ratios equal roughly 8.7, 6.6 and 4.3 for Z = 30, 60 and 95, respectively, independently of the transition energy and multipolarity. In the considered energy region, the internal conversion in the s-subshells is found to be dominant. (auth)

40156 TREATMENT OF THE LIPPMANN–SCHWINGER EQUATION FOR TWO INTERACTING PARTICLES IN A POTENTIAL. II. Gloeckle, W.; Heiss, W. D. (Univ., Heidelberg). Nucl. Phys., A132: 468-80(1969).

A decomposition into angular momentum states is introduced into the Lippmann–Schwinger equation. The coupled system for a finite number of partial waves, after elimination of the remaining infinite number, is shown to have a unique solution even for positive energies. For the homogeneous system the only nontrivial solution arises from bound states of the total Hamiltonian. The effective interaction occurring in this finite system is studied. An approximation of finite rank for the kernel is constructed. The final expressions for the various partial waves amplitudes are given. (auth)

40157 SHELL-MODEL APPROACH TO NUCLEAR REACTIONS. Mahaux, Claude; Weidenmueller, Hans A. New York, John Wiley and Sons, Inc., 1969. 356p. $16.00.

A complete and detailed description of the shell-model approach to nuclear reactions is presented. The various formalisms and methods of calculation of the scattering matrix are described and compared. In addition typical numerical results are physically interpreted. The theory is applied to the intermediate structure phenomenon, the optical model, the phenomenological coupled-channels approach for direct scattering, the DWBA and the isobaric analogue resonances. The analysis of isolated or poorly overlapping resonances in excitation functions is discussed, and the analytical properties of the S-matrix are described. (auth)

40158 INDUCED RADIOACTIVITY. Barbier, Marcel. New York, John Wiley and Sons, Inc., 1969. 437p. $21.00.

Topics discussed include physical phenomena involved in activation, general theorems and properties common to all reactions, activation by high energy particles producing spallation, fission products and activation by thermal to fast neutrons, compound nucleus reactions and threshold detectors, radioactivity induced by high energy electrons and photons, some aspects of radioactivity induced by heavy ions and radioactivity induced in tissues. (W.H.K.)

40159 PHYSICS OF NUCLEI AND PARTICLES. VOLUME I. Marmier, Pierre; Sheldon, Eric. New York, Academic Press, Inc., 1969. 825p. $17.50.

Topics discussed include the historical development of nuclear physics, the size and constitution of the atomic nucleus, nuclear radii and the liquid drop model of the nucleus, interactions and nuclear cross sections, passage of ionizing radiation through matter, nuclei and particles as quantum-mechanical systems, radioactivity, alpha decay, beta decay, radiative transitions in nuclei, internal conversion, and fundamental characteristics of nuclear reactions. Also, included in the appendix are discussions on kinetics of relativistic particles, transformation relations between the laboratory and center-of-mass systems for elastic collisions, the dynamics of decay and reaction processes, wave mechanics, angular momentum in quantum mechanics (Racah algebra), Feynman interaction theory, some measurement techniques in nuclear physics, and radiation dosimetry. (W.H.K.)

40160 CALCULATION OF THE CONTINUUM STATE AND NUCLEAR PHOTO-EFFECT. Fujii, S. (Nihon Univ., Tokyo). Nucl. Phys., A132: 385-409(1969).

A photo-effect mechanism in the energy region including the giant resonance is investigated by means of a model calculation. The calculation of the final states is performed, keeping a close relation with the conventional shell-model calculation. For this purpose, the configuration space is divided into two regions by a closed surface which is chosen in such a way that the interactions between the nucleons in the outside region, in fact, can be regarded as negligible except for the Coulomb force. For the wave function in the inside region, a trial function with unknown parameters is assumed and these parameters are determined by means of a variational principle. This method is useful for calculating not only the continuum state but also the bound state. ^{16}O photodisintegration is taken as an example to interpret our model. A comparison of our results with experiments is made for the excitation function, angular distribution and polarization. (auth)

40161 STRUCTURE OF THE GIANT RESONANCE OF ^{16}O FROM THE COUPLED-CHANNEL AND EIGENCHANNEL METHODS. Saruis, Anna Maria (Centre d'Etudes Nucleaires des Saclay, Gif-sur-Yvette, France); Marangoni, Marina. Nucl. Phys., A132: 433-44(1969).

The ^{16}O photoemission cross sections calculated with the coupled-channel method are compared with the results obtained from the eigenchannel reaction theory, assuming the same set of parameter values. Both calculations have been done in the frame of the 1p–1h approximation. The two calculations do not yield the same structure for the cross sections. Since the coupled-channel results are in agreement with those obtained by Buck and Hill and by Raynal et al., it was concluded that spurious peaks are obtained from the eigenchannel method. This supports the conclusions drawn by Mahaux and Weidenmüller from a critical analysis of the eigenchannel theory. It is confirmed that the fine structure of the ^{16}O giant resonance cannot be explained in the frame of the 1p–1h approximation. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 38028, 38096, 38162, 38197, 38371, 39019, and 40430.

40162 (APDA-CFE-30) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT, FEBRUARY 1969. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). June 1969. Contract AT(11-1)-865. 47p. Dep. CFSTI.

The restoration of the primary system for sodium refill is described; completion of lower plenum vacuuming, plenum inspection, and patching of the 14-inch line penetration are summarized. Mockup tests of the holddown mechanism inspection tool are discussed; results are outlined. Returning the transfer tank plugging indicator to service is summarized. Cover gas activity is tabulated for each sampling. Water manifold cover gasket replacements, sodium refill, and leak testing of the steam generators are discussed. Replacement of waste gas lines is described. The failure of a safety rod to detach from a steam cleaning chamber gripper is summarized. The new auxiliary fuel storage facility and fuel transfer facility which are being constructed inside the reactor building are described. (M.L.S.)

40163 (APDA-CFE-31) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT, MARCH 1969. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). June 1969. Contract AT(11-1)-865. 32p. Dep. CFSTI.

The refilling of the primary sodium system is described. Fuel transfer operations are tabulated. Difficulties encountered in the attempted transfer of a safety rod are described. Cover gas activities and analyses are tabulated. Details of the malfunction detection system are given. Repair of the steam cleaning chamber gripper is described. (M.L.S.)

40164 (APED-5453) VIBRATION ANALYSIS AND TESTING OF REACTOR INTERNALS. Wetzel, V. R.; Duckwald, C. S.; Head, M. A. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 1967. 16p.

The vibration test and measurement program is designed to determine the vibration response of key reactor internal components for coolant flow operating conditions. Components that make up the reactor internals are described, and vibration analysis methods are presented. Typical field tests on the internals are discussed. (H.D.R.)

40165 (CONF-681064-7) POWER REACTOR FUEL SUPPLIES AND SERVICES OF THE U.K.A.E.A. Waddams, J. A. (United Kingdom Atomic Energy Authority, Risley (England). Production Group). [1968]. 7p. Dep.

From British Nuclear Forum and Deutsches Atomforum Meeting, Frankfurt am Main, Germany.

The various components of the UKAEA fuel service and the facilities available are described. The mode of operation of the service in relation to a reactor in Germany is indicated. (UK)

40166 (DOCKET-1151-1) ELK RIVER REACTOR. Eightieth Monthly Operating Report, June 1969. (Rural Cooperative Power Association, Elk River, Minn.). Aug. 1, 1969. 14p. (COO-651-76). Dep. CFSTI.

40167 (DOCKET-1153-1) HNPF ENVIRONMENTAL MONITORING PROGRAM. Quarterly Report No. 32, April–June 1969. (Consumers Public Power District, Hallam, Nebr.). July 10, 1969. 4p. Dep. CFSTI.

40168 (DOCKET-50003-1) INDIAN POINT STATION: SURVEY OF ENVIRONMENTAL RADIOACTIVITY, AUGUST 1, 1968–JANUARY 31, 1969. (Consolidated Edision Co. of New York, Inc., New York). 22p. Dep. CFSTI.

40169 (DOCKET-50003-2) INDIAN POINT PLANT, UNIT NO. 1. CORE B CYCLE 2: GAMMA SCAN MEASUREMENTS. Clarke, W. G.; Klatt, R. D. (Westinghouse Electric Corp., [Pittsburgh, Pa.]). Aug. 6, 1969. 12p. Dep. CFSTI.

INDIAN POINT POWER REACTOR, UNIT 1—fuel elements for, results of γ scan measurements on Core B cycle 2 (M.L.S.)

40170 (DOCKET-50016-4) ENRICO FERMI ATOMIC POWER PLANT. [Monthly] Report, April 1969. (Power Reactor Development Co., Detroit, Mich.). 11p. (PRDC-EF-68). Dep. CFSTI.

40171 (DOCKET-50016-5) ENRICO FERMI ATOMIC POWER PLANT. [Monthly] Report, May 1969. (Power Reactor Development Co., Detroit, Mich.). 11p. (PRDC-EF-69) Dep. CFSTI.

40172 (DOCKET-50029-4) YANKEE NUCLEAR POWER STATION. [Final Hazards Summary Report], Amendment 15. (Yankee Atomic Electric Co., Boston, Mass.). Oct. 2, 1959. 204p. Dep. CFSTI.

Procedures for startup of the Yankee Power Reactor are detailed. Neutron shield tank maintenance instructions are given. Procedures for on-site handling and storage of fuel elements are listed; included are reactor refueling procedures. Revised or additional details are also given on core design and full core experiments; all other systems are discussed briefly. (M.L.S.)

40173 (DOCKET-50029-5) YANKEE NUCLEAR POWER STATION. Final Hazards Summary Report, Amendment 26. (Yankee Atomic Electric Co., Boston, Mass.). Apr. 3, 1961. 7p. Dep. CFSTI.

Modifications of the power range nuclear instrumentation for the Yankee Power Reactor are described. Circuitry modifications to provide annunciation and automatic load cut-back under loss of power supply are discussed; trip set-points are given. (M.L.S.)

40174 (DOCKET-50029-6) YANKEE NUCLEAR POWER STATION. Final Hazards Summary Report, Amendment 27. (Yankee Atomic Electric Co., Boston, Mass.). Apr. 12, 1961. 2p. Dep. CFSTI.

Information correcting the description of power range nuclear instrumentation modifications are given. The reference to low adjust alarm contacts on power range instrumentation is discussed; locations of low adjust alarms are described. (M.L.S.)

40175 (DOCKET-50029-7) YANKEE NUCLEAR POWER STATION. Final Hazards Summary Report, Amendment 42. (Yankee Atomic Electric Co., Boston, Mass.). June 28, 1962. 11p. Dep. CFSTI.

A description of the redesigned cruciform control rods for the Yankee Power Reactor is given. The design is discussed; a schematic is included. (M.L.S.)

40176 (DOCKET-50029-8) YANKEE NUCLEAR POWER STATION. Final Hazards Summary Report, Amendment 43. (Yankee Atomic Electric Co., Boston, Mass.). Oct. 19, 1962. 22p. Dep. CFSTI.

Revisions and additions to the original design and operations information for the Yankee Power Reactor are summarized; an index is included to organize the previously submitted material. (M.L.S.)

40177 (DOCKET-50029-9) YANKEE NUCLEAR POWER STATION. Final Hazards Summary Report, Amendment 44. (Yankee Atomic Electric Co., Boston, Mass.). Dec. 19, 1962. 8p. Dep. CFSTI.

A cross sectional view of the Yankee Power Reactor core, which shows the instrument locations, is given. Flux wire control and readout diagrams are presented. Core II flux wire instrumentation is described. (M.L.S.)

40178 (DOCKET-50029-10) YANKEE NUCLEAR POWER STATION. Final Hazards Summary Report, Amendment 45. (Yankee Atomic Electric Co., Boston, Mass.). July 17, 1963. 33p. Dep. CFSTI.

Data to support an increase in power level from 540 MWt to 600 MWt are included. Thermal analyses for the reactor at 540 MWt and 600 MWt are given; design data are tabulated. Coolant loss accidents are analyzed for both reactor power levels; results of analyses are shown graphically. (M.L.S.)

40179 (DOCKET-50029-11) YANKEE NUCLEAR POWER STATION. Final Hazards Summary Report, Amendment 46. (Yankee Atomic Electric Co., Boston, Mass.). Oct. 30, 1963. 10p. Dep. CFSTI.

Changes in procedures for control rod motion and rod sequencing in the Yankee Power Reactor are given. Changes in refueling procedures are described; procedural changes in cold leak tests of the primary system are given. (M.L.S.)

40180 (DOCKET-50029-12) YANKEE NUCLEAR POWER STATION. Final Hazards Summary Report, Amendment 47.

(Yankee Atomic Electric Co., Boston, Mass.). Dec. 27, 1963. 54p. Dep. CFSTI.

Organization of proposed Technical Specifications Changes 32, 34, 35, 36, 40, 41, 42, 43, 44, 45, and 48 is recorded. The changes made in each Change number are summarized. Change numbers 32 and 35 refer to minor changes to the pressure control and relief system; Change No. 34 pertains to alteration of locations of certain valves in the safety injection system; Change No. 36 deals with core loading patterns; Change No. 40 provides for replacement of the 24 existing nickel plated, Ag–In–Cd control rods with 22 hafnium and 2 inconel clad Ag–In–Cd control rods; installation of a valved vent in the low pressure surge tank was covered by Change No. 41; modifications to in-core instrumentation were described in Change Nos. 42 and 45; Change No. 43 described the replacement of the boron stainless steel sections of the shim rods with type 304 stainless steel sections; Change No. 44 described the addition of an Al storage rack to the fuel transfer pit; Change No. 48 referred to operating procedures updating. (M.L.S.)

40181 (DOCKET-50029–13) YANKEE NUCLEAR POWER STATION. Final Hazards Summary Report, Amendment 49. (Yankee Atomic Electric Co., Boston, Mass.). Dec. 7, 1964. 26p. Dep. CFSTI.

A record and description of changes made in the Yankee Power Reactor after license issuance are given. Information on Technical Specifications Changes Nos. 52, 56, 57, and 58 is presented. Change No. 52 involved removing the gas stripper from the radioactive waste treatment process and providing a pipe connection between the distillate accumulator vent and the stripper condenser; Change No. 56 concerned installation of a low level trip for the steam generator; Change No. 57 referred to core configuration and boron concentration required for Core IV operation; Change No. 58 described the removal of two capped stem isolation valves from the spray line to the pressurizer. (M.L.S.)

40182 (DOCKET-50029–14) YANKEE NUCLEAR POWER STATION. Final Hazards Summary Report, Amendment 50. (Yankee Atomic Electric Co., Boston, Mass.). Oct. 7, 1965. 14p. Dep. CFSTI.

Technical and design details for support of changes to the Technical Specifications for Yankee Power Reactor are given. Changes reflect a description of Core V, with the results of nuclear and thermal analyses, and relocation of two Zircaloy test assemblies in Core V. (M.L.S.)

40183 (DOCKET-50029–15) YANKEE NUCLEAR POWER STATION. Final Hazards Summary Report, Amendment 51. (Yankee Atomic Electric Co., Boston, Mass.). Jan. 28, 1966. 30p. Dep. CFSTI.

Design and operations changes to the Technical Specifications for the Yankee Power Reactor are recorded. Brief descriptions are given for Changes Nos. 53, 59, 61, 62, 64, 65, 66, 68, 69, 70, and 71. Change No. 53 pertains to repair of the pressurizer solenoid relief valve; Change No. 59 referred to relocation of the level detector for the safety injection tank; Change No. 61 involves coolant pH control; Change No. 62 refers to changes in the capacity of two main coolant letdown orifices; Change No. 64 describes the installation of a safety injection liquid heating and purification loop; Change No. 65 refers to reactor operation with two prototype stainless steel clad control rods in-core; modifications to the low pressure surge tank and associated piping are described in Change No. 66; Change No. 68 refers to installation of secondary core supports on the thermal shield; operation of Core V with three regenerative Sb–Be sources and one stainless blank is discussed in Change No. 69; Change No. 70 describes the installation of joint clamp assemblies to reinforce the bolted joints in the reactor thermal shield; and Change No. 71 discusses installation of a permanent filter station in the recirculation line of the evaporator. (M.L.S.)

40184 (DOCKET-50029–16) YANKEE NUCLEAR POWER STATION. Operation Report No. 1; Initial Startup and Testing, July 9, 1960–January 29, 1961. (Yankee Atomic Electric Co., Boston, Mass.). Feb. 13, 1961. 57p. Dep. CFSTI.

40185 (DOCKET-50029–17) YANKEE NUCLEAR POWER STATION. Operation Report No. 2, January 30, 1961–February 28, 1961. (Yankee Atomic Electric Co., Boston, Mass.). Mar. 8, 1961. 11p. Dep. CFSTI.

40186 (DOCKET-50029–18) YANKEE NUCLEAR POWER STATION. Operation Report No. 3, March 1961. (Yankee Atomic Electric Co., Boston, Mass.). Apr. 7, 1961. 9p. Dep. CFSTI.

40187 (DOCKET-50029–19) YANKEE NUCLEAR POWER STATION. Operation Report No. 4, April 1961. (Yankee Atomic Electric Co., Boston, Mass.). May 10, 1961). 8p. Dep. CFSTI.

40188 (DOCKET-50029–20) YANKEE NUCLEAR POWER STATION. Operation Report No. 5, May 1961. (Yankee Atomic Electric Co., Boston, Mass.). June 9, 1961. 8p. Dep. CFSTI.

40189 (DOCKET-50029–21) YANKEE NUCLEAR POWER STATION. Operation Report No. 6, June 1961. (Yankee Atomic Electric Co., Boston, Mass.). July 13, 1961. 9p. Dep. CFSTI.

40190 (DOCKET-50029–22) YANKEE NUCLEAR POWER STATION. License No. DPR-3; Technical Specifications, Change No. 7. (Yankee Atomic Electric Co., Boston, Mass.). May 8, 1961. 2p. Dep. CFSTI.

YANKEE POWER REACTOR — steam and power conversion system for, change of boiler trip circuit set-point in (M.L.S.)

40191 (DOCKET-50029–23) YANKEE NUCLEAR POWER STATION. Operation Report No. 7, July 1961. (Yankee Atomic Electric Co., Boston, Mass.). Aug. 9, 1961. 12p. Dep. CFSTI.

40192 (DOCKET-50029–24) YANKEE NUCLEAR POWER STATION. Operation Report No. 8, August 1961. (Yankee Atomic Electric Co., Boston, Mass.). Sept. 12, 1961. 7p. Dep. CFSTI.

40193 (DOCKET-50029–25) YANKEE NUCLEAR POWER STATION. Operation Report No. 9, September 1961. (Yankee Atomic Electric Co., Boston, Mass.). Oct. 11, 1961. 9p. Dep. CFSTI.

40194 (DOCKET-50029–26) YANKEE NUCLEAR POWER STATION. Operation Report No. 10, October 1961. (Yankee Atomic Electric Co., Boston, Mass.). Nov. 20, 1961. 25p. Dep. CFSTI.

40195 (DOCKET-50029–27) YANKEE NUCLEAR POWER STATION. Operation Report No. 11, November 1961. (Yankee Atomic Electric Co., Boston, Mass.). Dec. 15, 1961. 11p. Dep. CFSTI.

40196 (DOCKET-50029–28) YANKEE NUCLEAR POWER STATION. Operation Report No. 12, December 1961. (Yankee Atomic Electric Co., Boston, Mass.). Jan. 17, 1962. 9p. Dep. CFSTI.

40197 (DOCKET-50029–29) YANKEE NUCLEAR POWER STATION. Operation Report No. 13, January 1962. (Yankee Atomic Electric Co., Boston, Mass.). Feb. 19, 1962. 12p. Dep. CFSTI.

40198 (DOCKET-50029–30) YANKEE NUCLEAR POWER STATION. Operation Report No. 66, June 1966. (Yankee Atomic Electric Co., Boston, Mass.). July 22, 1966. 11p. Dep. CFSTI.

40199 (DOCKET-50029–31) YANKEE NUCLEAR POWER STATION. Operation Report No. 67, July 1966. (Yankee Atomic Electric Co., Boston, Mass.). Aug. 19, 1966. 11p. Dep. CFSTI.

40200 (DOCKET-50029–32) YANKEE NUCLEAR POWER STATION. Operation Report No. 68, August 1966. (Yankee Atomic Electric Co., Boston, Mass.). Sept. 20, 1966. 11p. Dep. CFSTI.

40201 (DOCKET-50029–33) YANKEE NUCLEAR POWER STATION. Operation Report No. 69, September 1966. (Yankee Atomic Electric Co., Boston, Mass.). Oct. 21, 1966. 12p. Dep. CFSTI.

40202 (DOCKET-50029–34) YANKEE NUCLEAR POWER STATION. Operation Report No. 70, October 1966. (Yankee Atomic Electric Co., Boston, Mass.). Nov. 25, 1966. 17p. Dep. CFSTI.

40203 (DOCKET-50029–35) YANKEE NUCLEAR POWER STATION. Operation Report No. 71, November 1966. (Yankee Atomic Electric Co., Boston, Mass.). Dec. 21, 1966. 12p. Dep. CFSTI.

40204 (DOCKET-50029–36) YANKEE NUCLEAR POWER STATION. Operation Report No. 72, December 1966. (Yankee Atomic Electric Co., Boston, Mass.). Jan. 25, 1967. 10p. Dep. CFSTI.

40205 (DOCKET-50029–37) YANKEE NUCLEAR POWER STATION. License No. DPR-3: Technical Specifications, Change No. 72. (Yankee Atomic Electric Co., Boston, Mass.). Aug. 1, 1966. 9p. Dep. CFSTI.

YANKEE POWER REACTOR—cooling system for, design for rerouting pressurizer capillary vent in primary (M.L.S.)

40206 (DOCKET-50029-39) YANKEE NUCLEAR POWER STATION. License No. DPR-3: Technical Specifications, Change No. 73. (Yankee Atomic Electric Co., Boston, Mass.). Aug. 31, 1966. 9p. Dep. CFSTI.

YANKEE POWER REACTOR—control rods for, design modifications allowing Zircaloy followers to be welded to absorber sections of (M.L.S.)

40207 (DOCKET-50029-40) YANKEE NUCLEAR POWER STATION. Operation Report No. 73, January 1967. (Yankee Atomic Electric Co., Boston, Mass.). Feb. 20, 1967. 11p. Dep. CFSTI.

40208 (DOCKET-50029-47) YANKEE NUCLEAR POWER STATION. Operation Report No. 76, April 1967. (Yankee Atomic Electric Co., Boston, Mass.). May 24, 1967. 9p. Dep. CFSTI.

40209 (DOCKET-50029-48) YANKEE NUCLEAR POWER STATION. Operation Report No. 77, May 1967. (Yankee Atomic Electric Co., Boston, Mass.). June 20, 1967. 10p. Dep. CFSTI.

40210 (DOCKET-50029-53) YANKEE NUCLEAR POWER STATION. Operation Report No. 78, June 1967. (Yankee Atomic Electric Co., Boston, Mass.). July 24, 1967. 10p. Dep. CFSTI.

40211 (DOCKET-50029-56) YANKEE NUCLEAR POWER STATION. Technical Specifications, Change No. 80. (Yankee Atomic Electric Co., Boston, Mass.). Jan. 4, 1968. 2p. Dep. CFSTI.

YANKEE POWER REACTOR—cooling system for, design modification for installation of single controllable orifice in (M.L.S.)

40212 (DOCKET-50029-57) YANKEE NUCLEAR POWER STATION. Operation Report No. 80, August 1967. (Yankee Atomic Electric Co., Boston, Mass.). Sept. 28, 1967. 9p. Dep. CFSTI.

40213 (DOCKET-50029-58) YANKEE NUCLEAR POWER STATION. Operation Report No. 81, September 1967. (Yankee Atomic Electric Co., Boston, Mass.). Oct. 30, 1967. 10p. Dep. CFSTI.

40214 (DOCKET-50029-59) YANKEE NUCLEAR POWER STATION. Technical Specifications, Change No. 81. (Yankee Atomic Electric Co., Boston, Mass.). Apr. 12, 1968. 4p. Dep. CFSTI.

YANKEE POWER REACTOR—fuel assemblies for, core loading configuration and irradiation conditions for Zircaloy-4 clad test (M.L.S.)

40215 (DOCKET-50029-60) YANKEE NUCLEAR POWER STATION. Operation Report No. 82, October 1967. (Yankee Atomic Electric Co., Boston, Mass.). Nov. 30, 1967. 10p. Dep. CFSTI.

40216 (DOCKET-50029-61) YANKEE NUCLEAR POWER STATION. Operation Report No. 83, November 1967. (Yankee Atomic Electric Co., Boston, Mass.). Dec. 22, 1967. 9p. Dep. CFSTI.

40217 (DOCKET-50029-62) YANKEE NUCLEAR POWER STATION. Technical Specifications, Change No. 83. (Yankee Atomic Electric Co., Boston, Mass.). Apr. 23, 1968. 1p. Dep. CFSTI.

YANKEE POWER REACTOR—core for, use of miniature fission chambers in (M.L.S.)

40218 (DOCKET-50029-63) YANKEE NUCLEAR POWER STATION. License No. DPR-3: Technical Specifications, Change No. 84. (Yankee Atomic Electric Co., Boston, Mass.). Apr. 17, 1968. 4p. Dep. CFSTI.

YANKEE POWER REACTOR—pressure vessel for, fatigue data on replacement stud for (M.L.S.)

40219 (DOCKET-50029-64) YANKEE NUCLEAR POWER STATION. Operation Report No. 84, December 1967. (Yankee Atomic Electric Co., Boston, Mass.). Jan. 22, 1968. 9p. Dep. CFSTI.

40220 (DOCKET-50029-70) YANKEE NUCLEAR POWER STATION. Operation Report No. 89, May 1968. (Yankee Atomic Electric Co., Boston, Mass.). June 24, 1968. 9p. Dep. CFSTI.

40221 (DOCKET-50029-71) YANKEE NUCLEAR POWER STATION. Operation Report No. 90, June 1968. (Yankee Atomic Electric Co., Boston, Mass.). July 19, 1968. 7p. Dep. CFSTI.

40222 (DOCKET-50029-72) YANKEE NUCLEAR POWER STATION. Operation Report No. 91, July 1968. (Yankee Atomic Electric Co., Boston, Mass.). Aug. 20, 1968. 8p. Dep. CFSTI.

40223 (DOCKET-50029-73) YANKEE NUCLEAR POWER STATION. Operation Report No. 92, August 1968. (Yankee Atomic Electric Co., Boston, Mass.). Sept. 20, 1968. 8p. Dep. CFSTI.

40224 (DOCKET-50029-74) YANKEE NUCLEAR POWER STATION. Operation Report No. 93, September 1968. (Yankee Atomic Electric Co., Boston, Mass.). Oct. 18, 1968. 8p. Dep. CFSTI.

40225 (DOCKET-50029-75) YANKEE NUCLEAR POWER STATION. Operation Report No. 95, November 1968. (Yankee Atomic Electric Co., Boston, Mass.). Jan. 2, 1969. 9p. Dep. CFSTI.

40226 (DOCKET-50029-76) YANKEE NUCLEAR POWER STATION. Operation Report No. 96, December 1968. (Yankee Atomic Electric Co., Boston, Mass.). Jan. 21, 1969. 9p. Dep. CFSTI.

40227 (DOCKET-50029-77) YANKEE NUCLEAR POWER STATION. Operation Report No. 94, October 1968. (Yankee Atomic Electric Co., Boston, Mass.). Nov. 15, 1968. 8p. Dep. CFSTI.

40228 (DOCKET-50029-78) YANKEE NUCLEAR POWER STATION. Operation Report No. 97, January 1969. (Yankee Atomic Electric Co., Boston, Mass.). Feb. 24, 1969. 9p. Dep. CFSTI.

40229 (DOCKET-50029-79) YANKEE NUCLEAR POWER STATION. Operation Report No. 98, February 1969. (Yankee Atomic Electric Co., Boston, Mass.). Mar. 19, 1969. 8p. Dep. CFSTI.

40230 (DOCKET-50029-80) YANKEE NUCLEAR POWER STATION. Operation Report No. 99, March 1969. (Yankee Atomic Electric Co., Boston, Mass.). Apr. 17, 1969. 7p. Dep. CFSTI.

40231 (DOCKET-50029-81) YANKEE NUCLEAR POWER STATION. License No. DPR-3: Technical Specifications, Change No. 8. (Yankee Atomic Electric Co., Boston, Mass.). May 8, 1961. 2p. Dep. CFSTI.

YANKEE POWER REACTOR—core cooling system for, alteration of circuitry and set-points for safety injection (M.L.S.)

40232 (DOCKET-50029-82) YANKEE NUCLEAR POWER STATION. License No. DPR-3: Technical Specifications, Appendix A. (Yankee Atomic Electric Co., Boston, Mass.). Aug. 30, 1962. 7p. Dep. CFSTI.

YANKEE POWER REACTOR—separation of, normal operating limits and protective set-points for (M.L.S.)

40233 (DOCKET-50029-83) YANKEE NUCLEAR POWER STATION. License No. DPR-3, 1968 Financial Statements and Summary of Financial Protection. (Yankee Atomic Electric Co., Boston, Mass.). Mar. 14, 1969. 4p. (YA-2731). Dep. CFSTI.

YANKEE POWER REACTOR—owners of, financial data on (M.L.S.)

40234 (DOCKET-50029-85) YANKEE TESTIMONY OF DR. C. K. BECK. (Yankee Atomic Electric Co., Boston, Mass.). Mar. 4, 1960. 21p. Dep. CFSTI.

The complete safety evaluation of the Yankee Power Reactor is given. Safety characteristics and engineered safety features are described. Coolant activities, waste disposal, operating procedures, and schedules are discussed. The technical specifications are evaluated; the ACRS report is considered. (M.L.S.)

40235 (DOCKET-50029-86) YANKEE NUCLEAR POWER STATION. AEC Staff's Proposed Technical Specifications. (Yankee Atomic Electric Co., Boston, Mass.). [nd]. 16p. Dep. CFSTI.

YANKEE POWER REACTOR—technical specifications for, listing of AEC-proposed (M.L.S.)

40236 (DOCKET-50029-88) YANKEE NUCLEAR POWER STATION. Emergency Core Cooling Systems Review. (Yankee Atomic Electric Co., Boston, Mass.). Jan. 12, 1968. 2p. Dep. CFSTI.

YANKEE POWER REACTOR—Emergency Core Cooling System for, proposed design modifications for (M.L.S.)

40237 (DOCKET-50029-89) YANKEE NUCLEAR POWER STATION. Use of Zircaloy Clad Fuel Elements. (Yankee Atomic Electric Co., Boston, Mass.). Mar. 24, 1969. 3p. Dep. CFSTI.

YANKEE POWER REACTOR—fuel elements for, criteria for using Zircaloy clad (M.L.S.)

40238 (DOCKET-50029-93) YANKEE NUCLEAR POWER STATION. License No. DPR-3: Technical Specifications, Change No. 84. (Yankee Atomic Electric Co., Boston, Mass.). Apr. 25, 1968. 1p. Dep. CFSTI.

YANKEE POWER REACTOR—pressure vessel for, fatigue data on replacement stud for (M.L.S.)

40239 (DOCKET-50029-94) YANKEE NUCLEAR POWER STATION. Operation Report No. 14, February 1962. (Yankee Atomic Electric Co., Boston, Mass.). Mar. 16, 1962. 9p. Dep. CFSTI.

40240 (DOCKET-50130-2) PATHFINDER ATOMIC POWER PLANT. License No. DPR-11. Six-Month Operating Report. Plant Operating Experience, November 19, 1968-May 19, 1969. (Northern States Power Co., Minneapolis, Minn.). June 13, 1969. 41p. (NSP-6901). Dep. CFSTI.

40241 (DOCKET-50155-10) BIG ROCK POINT NUCLEAR PLANT. Quarterly Operations Report No. 73, February-April 1969. (Consumers Power Co., Jackson, Mich.). 22p. Dep. CFSTI.

40242 (DOCKET-50213-5) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. [Final] Facility Description and Safety Analysis, Amendment 10, Vol. 1. (Connecticut Yankee Atomic Power Co., Boston, Mass.). May 1966. 376p. Dep. CFSTI.

CONNECTICUT YANKEE POWER REACTOR—site for, final safety analysis of
—containment systems for, final safety analysis of
—core for, final safety analysis of design for
—cooling systems for, final safety analysis of design for
—shielding for, final safety analysis of (M.L.S.)

40243 (DOCKET-50213-6) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. [Final] Facility Description and Safety Analysis, Amendment 10, Vol. 2. (Connecticut Yankee Atomic Power Co., Boston, Mass.). May 1966. 389p. Dep. CFSTI.

CONNECTICUT YANKEE POWER REACTOR—control systems and instrumentation for, final safety analysis of
—emergency and auxiliary systems for, final safety analysis of
—electrical systems for, final safety analysis of
—safety analyses for, final,
—operation of, final safety analysis of initial testing and proposed
—personnel for, organization of (M.L.S.)

40244 (DOCKET-50213-7) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. [Preliminary Safety Analysis Report], Amendment 5. (Connecticut Yankee Atomic Power Co., Hartford). Feb. 5, 1964. 41p. Dep. CFSTI.

CONNECTICUT YANKEE POWER REACTOR—owners of, 1962 financial data and balance sheets for (M.L.S.)

40245 (DOCKET-50213-8) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. [Preliminary Safety Analysis Report], Amendment 7. (Connecticut Yankee Atomic Power Co., Hartford). Mar. 2, 1964. 52p. Dep. CFSTI.

CONNECTICUT YANKEE POWER REACTOR—owners of, 1963 financial data and balance sheets for (M.L.S.)

40246 (DOCKET-50213-9) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. [Preliminary Safety Analysis Report], Amendment 11. (Connecticut Yankee Atomic Power Co., Boston, Mass.). Oct. 6, 1966. 71p. Dep. CFSTI.

Calculations of off-site doses following a maximum hypothetical accident in the Connecticut Yankee Power Reactor are detailed; results of calculations are shown graphically. Thyroid doses at site boundary are plotted as a function of containment leak rate and meteorological diffusion factor. Emergency core cooling is discussed; results of blowdown calculations are given; results and details are shown graphically. Containment integrity is evaluated; potential sources of energy under accident conditions are listed and discussed. Effects of control rod ejection are analyzed in detail. Thermal and hydraulic design of the core is detailed. (M.L.S.)

40247 (DOCKET-50213-10) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. [Preliminary Safety Analysis Report], Amendment 12. (Connecticut Yankee Atomic Power Co., Boston, Mass.). Jan. 11, 1967. 100p. Dep. CFSTI.

The proposed inspection and surveillance programs for the Connecticut Yankee Power Reactor primary system are described. Flow charts for reactor operator action are given for the following accident conditions: coolant loss, recirculation system failure, ECCS failure, and excessive containment leakage during an incident. Potential on-site and off-site environmental activity levels, subsequent to an accident, are discussed. Procedures and equipment for fire protection and prevention at the reactor are described. Reactor startup and isolated leap startup accidents are analyzed. (M.L.S.)

40248 (DOCKET-50213-11) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. [Preliminary Safety Analysis Report], Amendment 14. (Connecticut Yankee Atomic Power Co., Boston, Mass.). Mar. 6, 1967. 44p. Dep. CFSTI.

Effects of a positive moderator coefficient on potential reactivity insertions in Connecticut Yankee Power Reactor are analyzed. Analyses of transients resulting from coolant loss accidents are summarized. Effects of blowdown on the primary-to-secondary steam generator barriers are evaluated. Shear tests on the containment vessel liner are described; a stress diagram is shown. (M.L.S.)

40249 (DOCKET-50213-12) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. [Preliminary Safety Analysis Report], Amendment 15. (Connecticut Yankee Atomic Power Co., Boston, Mass.). Mar. 23, 1967. 8p. Dep. CFSTI.

Results and interpretation of containment vessel liner shear tests are discussed; stud loading and shear values are given. Quantitative and qualitative acceptance criteria for use in evaluation of containment pressure tests are described. Provisions for emergency power are discussed. The justification of testing intervals for protection system components and channels is outlined. (M.L.S.)

40250 (DOCKET-50213-13) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. [Preliminary Safety Analysis Report], Amendment 17. (Connecticut Yankee Atomic Power Co., Boston, Mass.). Jan. 8, 1968. 7p. Dep. CFSTI.

A revised analysis of a hypothetical main steam line rupture incident in the Connecticut Yankee Power Reactor is given. This analysis reflects an increase of main steam line isolation valve closure time to ten seconds with a circumferential double-ended rupture of the 36 inch main steam header. (M.L.S.)

40251 (DOCKET-50213-14) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. [Preliminary Safety Analysis Report], Amendment 19. (Connecticut Yankee Atomic Power Co., Boston, Mass.). Dec. 3, 1968. 11p. Dep. CFSTI.

CONNECTICUT YANKEE POWER REACTOR—coolant for, flow coastdown and transients resulting from loss of pumps for (M.L.S.)

40252 (DOCKET-50213-15) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 69-6, June 1969. (Connecticut Yankee Atomic Power Co., Boston, Mass.). July 25, 1969. 15p. (NYO-3250-36). Dep. CFSTI.

40253 (DOCKET-50219-22) [OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1]. Preliminary Safety Analysis Report, Amendment 41. (Jersey Central Power and Light Co., Morristown, N. J.). July 26, 1968. 14p. Dep. CFSTI.

On-site facilities for decontamination and immediate emergency treatment of injured personnel at the Oyster Creek Power Reactor, Unit 1 are described in detail. Facilities for off-site medical and clinical treatment are discussed. (M.L.S.)

40254 (DOCKET-50219-23) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Preliminary Safeguards Summary Report, Part B. (Jersey Central Power and Light Co., Morristown, N. J.). Mar. 30, 1964. 226p. Dep. CFSTI.

OYSTER CREEK POWER REACTOR, UNIT 1—site for, preliminary safety analysis of
—core for, preliminary safety analysis of design for
—cooling system for, preliminary safety analysis of design for
—containment systems for, preliminary safety analysis of
—engineered safeguards for, preliminary safety analysis of

—electrical systems for, preliminary safety analysis of
—emergency and auxiliary systems for, preliminary safety analysis of
—control systems and instrumentation for, preliminary safety analysis of
—radiation protection and waste handling at, preliminary safety analysis of
—operation of, preliminary safety analysis of proposed
—steam and power conversion systems for, preliminary safety analysis of
—safety analysis for (M.L.S.)

40255 (DOCKET-50219-24) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Provisional Operating License No. DPR-16, Amendment 1. (Jersey Central Power and Light Co., Morristown, N. J.). Aug. 1, 1969. 11p. Dep. CFSTI.

Limits on leakage from any isolation valve in the Oyster Creek Power Reactor, Unit 1 system are specified; reporting requirements concerning the nondestructive testing program are described; filter train flow rates are given for the modified standby gas treatment system. A maximum power level of 1600 MW(t) is specified. (M.L.S.)

40256 (DOCKET-50237-10) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Safety Analysis Report, Vol. 4. (Commonwealth Edison Co., Chicago, Ill.). Nov. 26, 1968. 412p. (DOCKET-50249-11). Dep. CFSTI.

Details on the containment vessels for Dresden Power Reactor, Units 2 and 3 are given. Included are: complete specifications, fabrication procedures and data, materials descriptions, results of tests, quality control records, and certifications. (M.L.S.)

40257 (DOCKET-50237-11) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Safety Analysis Report, Vol. 3. (Commonwealth Edison Co., Chicago, Ill.). Sept. 9, 1968. 126p. (DOCKET-50249-12). Dep. CFSTI.

DRESDEN POWER REACTOR, UNIT 2—Technical Specifications for, complete
DRESDEN POWER REACTOR, UNIT 3—Technical Specifications for, complete (M.L.S.)

40258 (DOCKET-50255-17) PALISADES PLANT. [Preliminary Description and Safety Analysis Report], Amendment 13. (Consumers Power Co., Jackson, Mich.). June 24, 1969. 22p. Dep. CFSTI.

Deletion of the Palisades Power Reactor thermal shield is discussed. Revised methods for predicting fast neutron fluence on pressure vessels are described; fast neutron fluence effects on NDTT are discussed. The hydraulic effects of thermal shield removal are analyzed. All data are shown graphically. (M.L.S.)

40259 (DOCKET-50255-18) PALISADES PLANT. Preliminary Description and Safety Analysis Report, Amendment 14. (Consumers Power Co., Jackson, Mich.). July 22, 1969. 151p. Dep. CFSTI.

Minimization of difficulties by preoperational testing of components for the Palisades Power Reactor is discussed. Personnel staffing requirements for the plant are given. Use of Zircaloy-4 as fuel assembly intermediate spacer grid spring material is analyzed; data on the mechanical properties of the Zircaloy-4 are shown graphically. Temperature differentials in the concrete structures are discussed; concrete temperatures are shown as a function of concrete thickness. Seismic damping factors used for the reinforced concrete and prestressed concrete structures are detailed. Details of the construction and fabrication of the concrete structures are considered. Results of performance tests on the containment air cooler equipment are outlined. The drainage system within the containment for the ECCS is described; a diagram is included. Location, range, sensitivity, and set-points are tabulated for area radiation monitors. (M.L.S.)

40260 (DOCKET-50263-22) MONTICELLO NUCLEAR GENERATING PLANT, [UNIT NO. 1]. Final Safety Analysis Report, Amendment 15. (Northern States Power Co., Minneapolis, Minn.). July 2, 1969. 87p. Dep. CFSTI.

The prestartup environmental radiation monitoring program for the Monticello Power Reactor is detailed. Blowdown effects on the core and internals are analyzed. The containment pressure suppression and drywell design are discussed; plant structures and systems are tabulated by class; load considerations and allowable stresses are listed for each building or component. Penetrations of the primary containment are tabulated. (M.L.S.)

40261 (DOCKET-50286-16) INDIAN POINT NUCLEAR GENERATING UNIT NO. 3. PROVISIONAL CONSTRUCTION PERMIT NO. CPPR-62. (Consolidated Edison Co. of New York, Inc., New York). Aug. 13, 1969. 76p. Dep. CFSTI.

40262 (DOCKET-50289-13) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Safety Evaluation by the Division of Reactor Licensing. (Metropolitan Edison Co., Reading, Pa.). Feb. 5, 1968. 90p. Dep. CFSTI.

THREE MILE ISLAND POWER REACTOR, UNIT 1—safety evaluation of, USAEC Division of Reactor Licensing (M.L.S.)

40263 (DOCKET-50289-14) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Addendum to the Safety Evaluation by the Division of Reactor Licensing. (Metropolitan Edison Co., Reading, Pa.). Apr. 26, 1968. 12p. Dep. CFSTI.

THREE MILE ISLAND POWER REACTOR, UNIT 1—safety of, statistical evaluation of effects of airplane crashes on (M.L.S.)

40264 (DOCKET-50289-15) THREE MILE ISLAND NUCLEAR STATION, [UNIT 1]. Preliminary Safety Analysis Report, Amendment 10. (Metropolitan Edison Co., Reading, Pa.). Mar. 28, 1968. 58p. Dep. CFSTI.

Detailed statistical data on the probability of an aircraft striking the Three Mile Island Power Reactor, Unit 1 are given. Effects of a hypothetical strike are discussed. Stability of the reactor containment structure under impact of the total aircraft is analyzed; data are shown graphically. The assumption of an aircraft strike on the Three Mile Island site is discussed; the probability of a strike by a very large aircraft (~200,000 lb.) at a high angle (>60°) on a critical structure is evaluated; the probability of a strike by a small aircraft is considered. (M.L.S.)

40265 (DOCKET-50289-16) THREE MILE ISLAND NUCLEAR STATION, [UNIT 1]. Preliminary Safety Analysis Report, Amendment 8. (Metropolitan Edison Co., Reading, Pa.). Feb. 26, 1969. 29p. Dep. CFSTI.

THREE MILE ISLAND POWER REACTOR, UNIT 1—site for, probabilistic analysis of aircraft crashing onto (M.L.S.)

40266 (DOCKET-50302-10) CRYSTAL RIVER [NUCLEAR GENERATING PLANT], UNIT 3. Preliminary Safety Analysis Report, Amendment 7. (Florida Power Corp., St. Petersburg). July 16, 1969. 315p. Dep. CFSTI.

The quality assurance program for the Crystal River Power Reactor, Unit 3 is detailed; organization charts show responsibilities and assignments. Details on control rod drive design modifications are given; reactivity rate limits and operational patterns are described. Protection of the plant from effects of hurricanes is discussed; probable maximum hurricane parameters are computed. Results of model tests to determine extreme wave runup at the Crystal River site are discussed; data are presented in graphic and tabular form. The engineering geology and foundation investigations for the site are described; construction of the containment system is described; prestressing procedures and post tensioning systems are described. The detailed report on the foundation investigations is included; specifications for excavation and construction of structural fill are given. (M.L.S.)

40267 (DOCKET-50321-12) EDWIN I. HATCH NUCLEAR PLANT, [UNIT 1]. Safety Evaluation by the Division of Reactor Licensing. (Georgia Power Co., Atlanta). Aug. 11, 1969. 110p. Dep. CFSTI.

40268 (DOCKET-50322-12) SHOREHAM NUCLEAR POWER STATION, [UNIT 1]. Preliminary Safety Analysis Report, Amendment 6. (Long Island Lighting Co., Mineola, N. Y.). June 30, 1969. 157p. Dep. CFSTI.

Revised information on the containment system design for the Shoreham Power Reactor is given. Loading criteria for the nuclear steam supply system are tabulated; each criterion is detailed. Minimum requirements for core cooling capability are discussed. Relative settlements between adjacent buildings under static and dynamic loads are considered. (M.L.S.)

40269 (DOCKET-50323-7) DIABLO CANYON, UNIT 2. Preliminary Safety Analysis Report, Amendment 4. (Pacific Gas and Electric Co., San Francisco, Calif.). July 10, 1969. 209p. Dep. CFSTI.

The support structures for the cooling system components for the Diablo Canyon Power Reactor, Unit 2 are described. Containment structure design modifications are discussed; stress analyses are detailed and calculations are included. Liner buckling patterns are analyzed; stress diagrams are shown. Containment reinforcing

and loading diagrams are given. The design of the fan cooler filtering units for the containment ventilating system is described. Trip set-points for the reactor control systems and instrumentation are given. Electrical power supplies and load requirements for emergency safeguards are tabulated. Design of the auxiliary salt water system is described; schematics and flow sheets are included. The quality assurance program is detailed; organization of the program and personnel responsibilities are described. (M.L.S.)

40270 (DOCKET-50324-12) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 9. (Carolina Power and Light Co., Raleigh, N. C.). July 18, 1969. 7p. (DOCKET-50325-12). Dep. CFSTI.

New completion dates for Brunswick Power Reactor, Units 1 and 2 are given. Costs of construction for completion on the new schedule are estimated. (M.L.S.)

40271 (DOCKET-50333-6) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, Amendment 3, Suppl. 2. (Power Authority of the State of New York). July 22, 1969. 89p. Dep. CFSTI.

Analytical methods for evaluating the seismic design of the James A. Fitzpatrick Power Reactor, Unit 1 are described; subgrade stiffness values are given. The quality assurance program is described; personnel assignments and responsibilities are tabulated. Personnel qualifications are listed. Field surveillance and inspection plans are detailed. (M.L.S.)

40272 (DOCKET-50335-7) HUTCHINSON ISLAND PLANT, UNIT NO. 1. Preliminary Safety Analysis Report, Amendment 2. (Florida Power and Light Co.). Aug. 1, 1969. 45p. Dep. CFSTI.

Results of refraction seismic exploration of the site for Hutchinson Island Power Reactor, Unit 1 are discussed; foundation studies are described. A stability analysis of the intake channel slopes is performed assuming seismic forces from the design basis earthquake. Foundation safety factors are discussed with respect to overall dynamic stability of the compacted backfill and ultimate bearing capacities; a settlement analysis is given for critical plant structures. Test borings are shown; field and laboratory data are listed. Details of soil liquefaction studies are analyzed. (M.L.S.)

40273 (DOCKET-50338-7) NORTH ANNA POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 1. (Virginia Electric and Power Co., Richmond). July 15, 1969. 295p. (DOCKET-50339-7). Dep. CFSTI.

Additional and revised information on the North Anna Power Reactor, Units 1 and 2 is given on the following broad topics: Site; Containment System; Engineered Safeguards; Electrical System; Auxiliary and Emergency Systems; Steam and Power Conversion Systems; Radiation Protection and Waste Disposal; Safety Evaluation; and Quality Assurance. (M.L.S.)

40274 (DOCKET-50338-8) NORTH ANNA POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 2. (Virginia Electric and Power Co., Richmond). Aug. 4, 1969. 9p. (DOCKET-50339-8). Dep. CFSTI.

The geological characteristics of the site for the North Anna Power Reactor, Units 1 and 2 are summarized; subsurface profiles are shown. (M.L.S.)

40275 (GAMD-8726) SUMMARY OF PCRV LINER RESEARCH AND DEVELOPMENT TEST PROGRAMS FOR THE FORT ST. VRAIN REACTOR PLANT. Bucon, H. W. (Gulf General Atomic, Inc., San Diego, Calif.). May 6, 1969. Contract AT(04-3)-633. 92p. Dep. CFSTI.

During hypothetical accidents which result in pressures higher than the maximum credible pressure, the prestressed concrete reactor vessel (PCRV) liner will go into a state of biaxial tension. To verify the integrity of the liner during such an accident, three test programs were initiated. The test programs were conducted to: (1) determine the ductility of two candidate liner materials under biaxial tension loading conditions, (2) demonstrate the ability of the selected liner and anchor design to withstand the normal biaxial compression loading conditions without developing deformations, and (3) determine the shear load carrying capability of the cooling water tubes attached to the PCRV cavity and penetration liners and demonstrate that the cooling tubes can accept the shear deflections improved on them by relative movement between the liners and adjacent concrete. The procedures and results of the test programs are presented. (H.D.R.)

40276 (INR-1036) COMMENTS ON THE OPTIMIZATION OF THE START-UP OF NUCLEAR POWER SYSTEM IN POLAND. Frankowski, Waclaw (Institute of Nuclear Research, Warsaw (Poland)). 1968. 23p. (In Polish). Dep.

The program concerned with the development of the nuclear power system in Poland is described. The first preliminary analysis of the possible build-up of the nuclear power system in the period 1980 to 2000 is analyzed. The aim of the analysis is to clarify some detailed questions concerning the practical solutions of the optimization problem. Despite its preliminary character some general conclusions are made. 9 references. (auth)

40277 (ORNL-TM-2493) PHYSICS, THERMAL-HYDRAULIC, AND FUEL CYCLE COST ANALYSES OF A METALLIC URANIUM DIRECT REPLACEMENT CORE FOR PWR'S. Welfare, F. G.; Jones, J. E. (Oak Ridge National Lab., Tenn.). July 11, 1969. 40p. Dep. CFSTI.

The Diablo Canyon pressurized water reactor is analyzed with the oxide fuel replaced by annular metal pins. Thermal-hydraulic, physics, and fuel-cycle economics analyses are presented. The results show possible savings of up to .3 mills per kilowatt hour electric in fuel cycle costs. The possible effects of uncertainties in physics results, physics procedures, and fuel element performance are considered. The effect of these uncertainties may be to reduce the saving in fuel cycle cost to less than .1 mill per kilowatt hour electric. Perhaps the most significant result is that the metal fueled systems have the potential for sharply reducing the separative work and ore requirements for an industry of pressurized water reactors. 14 references. (auth)

40278 (ZJE-44) SOME ASPECTS OF ROD CLUSTER TYPE FUEL ASSEMBLIES OPERATION AND HOT CHANNEL FACTOR CALCULATIONS. Krett, V.; Vlcek, J.; Weber, P. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Plant Div.). May 1969. 35p. Dep.

Calculations of the hot channel factor for HWGCR fuel rods of the Bohunice Power Reactor Unit I are described. Two methods of calculation are discussed: the statistical method and the cumulative one. The complete mathematical procedure of the statistical evaluation is derived. On the basis of experimental investigations the evaluation of some subfactors is given. As a result of calculation the maximum surface temperature for both methods is obtained. From the comparison of these calculations a difference of 18.2% is evident. The proposed method is generally applicable to all types of reactors. 33 references. (auth)

40279 SUMMARY OF NSIC ACTIVITIES, 1963-1968. Buchanan, J. R.; Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Design, 9: 396-407(Apr. 1969).

The Nuclear Safety Information Center (NSIC) serves as a focal point for the collection, analysis, and dissemination of information related to safety problems encountered in the design, analysis, and operation of nuclear facilities. NSIC issues state-of-the-art reports, operates a Selective Dissemination of Information (SDI) program, publishes indexed bibliographies, prepares retrospective bibliographies, answers technical inquiries, and offers counsel and guidance on safety problems. Its reference files are stored in a central computer that is accessible by means of a telecommunications station. The services offered by the Center, the manner in which it operates, and some of the problems encountered in its first 5½ years of operation through 31 December 1968 are described. NSIC's productivity and the demand for its services have increased significantly since its formation in 1963. Technical questions are answered at a rate of 609 per year. The biweekly SDI abstract service is now reaching 1500 participants. Reports and indexed bibliographies are issued routinely to a distribution of over 700. Visits to the Center for consultation and/or of its files occur at the rate of around 150 per year. 9 references. (auth)

40280 IMPROVEMENTS IN NUCLEAR REACTOR POWER PLANTS. (to Babcock and Wilcox Co.). British Patent 1,153,075, May 21, 1969. Priority date Sept. 8, 1965, United States.

HEAT TRANSFER SYSTEMS—flow diagram for superheating fast breeder power reactor primary and secondary
REACTORS, BREEDER—cooling system for superheating fast power of, flow diagram for primary and secondary
REACTORS, FAST—cooling system for superheating breeder power, flow diagram for primary and secondary
REACTORS, POWER—cooling system for superheating fast breeder, flow diagram for primary and secondary
REACTORS, SUPERHEATING—cooling system for fast breeder power, flow diagram for primary and secondary (D.C.C.)

40281 GAS TURBINE PLANT WITH NUCLEAR REACTOR. (to Escher Wyss Aktiengesellschaft). British Patent 1,152,686, May 21, 1969. Priority date Aug. 12, 1965, Switzerland.

HEAT TRANSFER SYSTEMS—flow diagram for gas cooled power reactor valve actuated emergency loop direct cycle
REACTORS, GAS-COOLED—cooling system for power of flow diagram for valve actuated emergency loop for direct cycle
—turbines for power, description of direct cycle gas
REACTORS, POWER—cooling system for gas cooled, flow diagram for valve actuated emergency loop for direct cycle
—turbines for gas cooled, description of direct cycle gas
TURBINES—design of direct cycle gas, for use with gas cooled power reactors (D.C.C.)

40282 WORLD POWER REACTORS IN 1969. Kadlec, J. (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ., 15: 183-92(June 1969). (In Czech).

A review of present power reactors in Member States of the International Atomic Energy Agency in 1969 is compiled in tables giving the main parameters of the reactors. (auth)

40283 THE REDUCTION OF THE SPECIFIC INSTALLATION COST OF LARGE POWER PLANTS. Haack, P. (Kraftwerk Union AG, Erlangen, Ger.). Brennst.-Waerme-Kraft, 21: 299-305(June 1969). (In German).

As the use of nuclear power for large scale commercial power supply grows, it is becoming increasingly necessary, when deciding on the type of plant to choose, to consider what fuel can be expected to give the lowest cost of power for a given distribution network. This choice depends on the state of the art and on various other factors such as the cost per therm, the plant load-factor and the plant capacity. A knowledge of the specific installation cost is of the utmost importance, particularly when considering the use of very high capacity units. Considerations on the reduction of specific installation costs based on conventional high capacity power stations are not always applicable. 13 references. (auth)

40284 APPRAISAL STUDY OF REPORTED OPERATING EXPERIENCES OF VARIOUS FAST BREEDER REACTORS IN THE WORLD. III. DOUNREAY FBR. Nakagawa, Hiroshi; Futami, Tsuneo (Tokyo Electric Power Co., Inc.). Nippon Genshiryoku Gakkaishi, 11: 362-8(1969). (In Japanese).

The operating experiences of the Dounreay FBR, are reviewed and evaluated. 27 references. (auth)

40285 FABRICATION OF FUEL ELEMENTS FOR THE ARDENNES NUCLEAR POWER PLANT. Huberlant, M. A.; Gerard, J. (Metallurgie et Mecanique Nucleaires, Dessel, Belg.). Ind. Chim. Belge, 32: Special No., (Vol. 1), 767-70(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

The various aspects of fabrication of the UO_2 pellets, the fuel tubes, and the fuel element parts are described. Emphasis is placed on the inspection and control procedures to guarantee a high quality element on final assembly. (H.D.R.)

40286 CALCULATION OF THE QUADRATIC REGULATION AREA OF THE OUTPUT TEMPERATURE OF CO_2 FROM THE A 1 REACTOR. Polak, V. Bull. EGU, No. 3-4, 16-21(1968). (In Czech).

Described is a method of investigating the course of the quadratic regulation area of the control circuit of the output temperature of CO_2 from the A 1 reactor for various defects in the circuit under the conditions of power starting. The course is investigated above the plane of the parameters K_p and K_j of the controller of the CO_2 temperature. The calculation is carried out by means of a MINSK 22 automatic digital computer. (auth)

40287 ANALYSIS OF THE CONTROL CIRCUIT OF THE A 1 NUCLEAR POWER PLANT WITH REAL CONTROLLERS ON OUTPUT LEVELS OF 100 AND 66 PERCENT BY MEANS OF AN ANALOG COMPUTER. Kuklik, B. Bull. EGU, No. 3-4, 11-16(1968). (In Czech).

Analysis of the control system of the A 1 nuclear power station on the nominal and the 66% output level is reported. It was the aim of the analysis to determine the optimum setting of the individual controllers and to compare the results obtained on both output levels. The analysis was performed by means of an analog computer with controllers, which are taken into account for equipping the control system of the A 1 power plant. (auth)

40288 INVESTIGATION OF TRANSITION PROCESSES IN CONTROL CIRCUITS OF THE A 1 REACTOR ON THE OUTPUT LEVELS OF 100, 66, AND 33 PERCENT. Stirsky, P. Bull. EGU, No. 3-4, 3-10(1968). (In Czech).

The influence of parameters of controllers and detectors on the control processes of the reactor in the atomic power plant A 1 for output levels of 33% to 100% is analyzed. The influence of parameters of the thermoelements, temperature controller, and auxiliary control loop based on the gas flow-rate is studied. The analysis has been done with an analog computer. In the conclusion, criteria for an adaptive temperature controller are specified. (auth)

40289 MEASUREMENT OF THE ACTIVITY OF SAMPLES OF TECHNOLOGICAL AND COOLING WATERS IN THE A 1 NUCLEAR POWER PLANT. Blazek, J.; Zubzanda, O. Bull. EGU, No. 3-4, 56-9(1968). (In Czech).

Methods for controlling the activity of technological, cooling, and waste waters in the A 1 Nuclear Power Station are described. Attention is paid in particular to the measurement of low activities and to the determination of the maximum energy of β radiation in mixed β-ray sources. (auth)

40290 CALCULATION OF THE FREQUENCY AND TIME CHARACTERISTICS OF TEMPERATURE TRANSITIONS OF THE A 1 REACTOR ON DIGITAL COMPUTER. Karpeta, C. Bull. EGU, No. 3-4, 21-4(1968). (In Czech).

Described are methods of calculating the frequency characteristics (real, imaginary, amplitude, and phase) and the use of the above for the calculation of time characteristics (pulse, transition, and response for a unit linear function) in asymptotically stable transitions of three types: rotational broken transitions, transcendental transitions of the type exp to a rational broken function, and their product with a digital computer. The methods worked out were used to calculate the dynamic characteristics of temperature transitions of the A 1 reactor in different output levels. (auth)

40291 TESTS OF THE AUTOMATIC EQUIPMENT OF POWER PLANT A 1 ON STANDS IN THE POWER RESEARCH INSTITUTE. Kurka, J. Bull. EGU, No. 3-4, 30-3(1968). (In Czech).

The results of tests of the final design of automatic equipment for the technologic loops of power plant A 1 on stands in the Power Research Institute are evaluated. (auth)

40292 ANALYSIS OF THE FUNCTION OF THE TECHNOLOGICAL EQUIPMENT OF THE PRIMARY CIRCUIT OF THE A 1 NUCLEAR POWER STATION IN CASE OF EMERGENCY AFTERCOOLING AND FAILURE OF THE TURBO-COMPRESSORS. Zajic, A. Bull. EGU, No. 3-4, 33-6(1968). (In Czech).

Discussed are the course of the emergency aftercooling of the nuclear power plant A 1 reactor, emergency signals, functions of the automatic system of the aftercooling, and comparison of the transient states in full power operation and in operation with lower reactor power and gas pressure and temperature. The causes of the failures of the gas circulators and the function of their protective system are analyzed. (auth)

40293 CALORIMETRIC METHOD OF MEASURING THE BURNUP OF THE FUEL ELEMENTS IN THE A 1 NUCLEAR POWER STATION. Novak, S.; Beres, J.; Budinsky, M. Bull. EGU, No. 3-4, 37-41(1968). (In Czech).

The possibilities of continuous measurement of the burnup of the fuel elements in the A 1 Nuclear Power Station by means of the calorimetric method are analyzed. It is shown how to determine the integral heat output from individual reactor channels and to ascertain on this basis the mean burnup of a fuel element as well as the change of its isotopic composition. (auth)

40294 BURST CARTRIDGE DETECTION. Hladky, E.; Melichar, Z. Bull. EGU, No. 3-4, 41-6(1968). (In Czech).

The most important dosimetric control of the nuclear power station is the detection of a burst cartridge. Methods usable for burst cartridge detection in gas-cooled reactor are described. The problems involved in the design of the detection system, principal demands influencing the selection of the detection method, and the design of the system are discussed. Procedures of ensuring the control of the fuel elements in the A 1 Nuclear Power Station and main principles for designing the system for the A 2 Power Station are presented. (auth)

40295 NUCLEAR PARK CONCEPT. Muysken, M. Atoomenergie Haar Toepass., 11: 103-7(Apr. 1969). (In Dutch).

The political, organizational, technical and safety aspects of large nuclear power complexes are discussed on the basis of a report, entitled "The Future of Power Generation," prepared in 1968 for the centennial of the Koningklijke Machinefabriek Stork, N. V., Hengelo, the Netherlands. The unit cost of the generated

electrical energy may be reduced, resulting in a saving of $6 billion in Western Europe by creating such complexes. Each complex or "nuclear park" would contain 5 reactors of 5000 MW. It is unlikely that pressure vessels could be constructed for such large reactors before 1975. Cooling with fresh water would require a lake area of 5 km^2 with a flow rate of 40 m^3/sec for each 1000 MW. Salt-water cooling could be provided by 10-m diameter ducts, extending far into the ocean. In view of the low probability of simultaneous accidents at two or more independent reactors, the safety measures could be kept economical, unless all reactors would be contained in a single vessel, as was proposed in the report. No special economic advantage is expected to be derived from the transportation of the generated power. The article views the report as being too optimistic. 8 references. (TTT)

40296 THE MONT ARRET POWER PLANT: EL-4. Leveque, R. (CEA, Gif-sur-Yvette, France); Jacquin, J. C.; Leroy, C.; Moinereau, P. pp 411-35 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968. (In French).

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The principles which govern the breakdown of the power station into functions, assemblies, and sub-assemblies are described. This breakdown is used to define control levels, and the specific role of different items of equipment (wired logic and analogue circuits, based on the centralized data-processing equipment). The data-processing functions performed by the computer are reviewed. The structure of the automation system is then given in detail: for each of the components of the functional breakdown, the computer works out the present state and a desired state. The nature of the orders and data transmitted between the computer and the logic and analogue circuits is described; in particular the importance of calculation in working out orders and set values is demonstrated. The practical consequences of choices made in the design of the installation are discussed, and what precautions were taken to ensure reliability in carrying out orders and in control being taken over by the operator at the various levels of the breakdown are shown. (auth)

40297 SAINT-LAURENT-DES-EAUX POWER PLANT: EDF-4. Benmergui, A. (Electricite de France, Paris). pp 437-57 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968. (In French).

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

In the light of the experience gained in designing the three Chinon stations, it is shown how the designers of the EDF 4 control system were encouraged to entrust automation functions to a computer linked with simple sub-assemblies incorporating electromagnetic relays. The breakdown of the power plant control into "functions," the role of the various automatic systems, and the role of the computer, particularly in automation, are described. Also described are the specifications of the computers and peripherals used, the size and design of the data-processing system, as well as the links between the digital assemblies and the other analogue control assemblies in the power plant. (auth)

40298 UTILIZATION OF A DIGITAL COMPUTER FOR THE MANAGEMENT OF THE COMPLICATED AUTOMATION PARTICULAR TO THE EL-4 NUCLEAR POWER PLANT. Martinot, G. (CEA, Paris). pp 479-501 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968. (In French).

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The application of the general EL-4 control principles to the CO_2 forced circulation, which is very complex and particularly important in respect of EL-4, is described. A brief account is given of the characteristics of the circuit and equipment for forced circulation. The importance of their operation is emphasized, and reasons are given. The operators' work in connection with this function and in particular, their respective responsibilities and those of computers in the management of such, is examined. The role of the computer as regards blower regulation and its importance in the limitation of transient conditions are described. The role of computers in maintaining this function and ensuring the safety of equipment is discussed. The organization of computer programs concerning forced circulation and the main incidents which occurred during one year of operation are described. (auth)

40299 MONTS D'ARREE NUCLEAR POWER STATION: EL-4. Leveque, R. (CEA, Gif-sur-Yvette, France); Lemeur, R.; Jego, C.; Gheeraert, P. pp 683-93 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968. (In French).

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The various types of problems met in the introduction of digital systems incorporating a computer are described. A description is given of problems connected with the integration of centralized data-processing tests in the general planning of the station. An explanation is given of several different kinds of test phases. The working methods that had to be adopted to deal with the above problems are shown, and in particular the need for very detailed scheduling of tests of different phases. The question of making changes at various planning stages are explained. In addition, problems are described which involve the teaching of operators to converse with the equipment, methods used in regard to personnel, organization and procedures for intervention in machine programs, and statistics of non-availability resulting from intervention. (auth)

40300 SAINT-LAURENT-DES-EAUX NUCLEAR POWER PLANT: EDF-4. Benmergui, A.; Dive, P. (Electricite de France, Paris). pp 695-704 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968. (In French).

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

Computers at the EDF 1 power station have been operating since 1960 and 1961. Results of using this equipment are given along with those obtained using computers of more modern design, and also peripherals such as data acquisition equipment. Problems posed by the environment (temperature, interference, etc.) together with the research done and results obtained are described. (auth)

40301 ENEL'S EXPERIENCE ACQUIRED WITH THE INSTALLATION AND OPERATION OF ON-LINE COMPUTERS IN NUCLEAR POWER STATIONS. Galliani, M. (Ente Nazionale per l'Energia Elettrica, Rome); Gangemi, F.; Mazzanti, T.; Noviello, L.; Prato, A. G.; Montois, P. pp 705-22 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The use of computers at ENEL's three nuclear power stations at Trino, Garigliano and Latina is described with special reference to the problems associated with installation, debugging and operation. (auth)

40302 UTILIZATION OF THE DIGITAL COMPUTER FOR FUEL ELEMENT MANAGEMENT AT THE MONTS D'ARREE NUCLEAR POWER PLANT: EL-4. Leveque, R. (CEA, Gif-sur-Yvette, France); Dunant, Ph.; Lestum, J. pp 775-92 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968. (In French).

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The application of digital computer controlled automation to a medium scale mechanical process is described. When the reactor is in operation, fuel handling consists of loading fuel elements into the core and removing them from it for storage in a storage pond. In the case of EL 4, this is carried out by two charging machines which can work simultaneously on both sides of the reactor and which are supported by two moving platforms that provide vertical travel. Two machines remove the irradiated fuel elements hydraulically and convey them to the storage pond. A feature of these machines is that they must perform a large series of mechanical movements logically one after the other, and that they contain hydraulic circuits in which temperature, pressure and flow must be controlled. All the functions related to fuel handling are regulated by a digital computer. (auth)

40303 THE ON-LINE COMPUTER AT THE DRESDEN NUCLEAR POWER STATION AND ITS USE IN NUCLEAR FUEL MANAGEMENT. Pekarek, H. (Electro-Watt Engineering Services, Ltd., Zurich); Veras, A. F. pp 793-817 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

A description is presented of the on-line computer for the Dresden Nuclear Power Plant and its functions. The nuclear fuel management discipline is defined, and the computer requirements for fuel cycle studies are analyzed. Various aspects of the use of process computers for fuel management work are then examined

in detail within the framework of the nuclear power program of the Commonwealth Edison Company. 9 references. (auth)

40304 USE OF THE PROCESS COMPUTER AT THE HALDEN BOILING HEAVY WATER REACTOR TO CONTROL REACTOR EXPERIMENTS. Griess, F.; Kjaerheim, G.; Rolstad, E. (Organization for Economic Co-operation and Development, Halden, Norway). pp 819-38 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

During the operation period 1966 to 1969 HBWR will contain up to 80 instrumented fuel assemblies with a total number of about 650 in-core instruments. Most of these instruments are directly or indirectly connected to the process computer for routine logging as well as for the performance of special in-core experiments. The most important of these experiments is an initial calibration to relate the assembly power, as measured by a calorimetric heat balance, to the signals from the power sensors (γ thermometers or neutron detectors). The process computer and an associated XY-recorder are used for visual monitoring of the progress of the experiments, and for data collection and reduction. The program can at present collect data from 20 assemblies simultaneously, and on-line plots can be made from up to four assemblies. Digital printout can be requested from all involved assemblies at any time during the experiment. The experience with this system shows that it both saves experimental time and improves the quality of the results compared with earlier techniques. Performance of the equipment is reviewed. 2 references. (auth)

40305 APPLICATION OF ON-LINE COMPUTERS TO NUCLEAR REACTORS. Seminar Held at Sandefjord, Norway, September 2-6, 1968. Paris, Organization for Economic Co-operation and Development, 1968. 904p. F 85; FS 78; DM 70; £ 7.5s.; $20.00. (In French and English). (CONF-680917).

Information on the use of on-line digital computers for nuclear reactor control is presented. Separate abstracts are included for 38 of the 39 papers presented. One of the papers was previously included in NSA Vol. 22: 48734. (D.C.C.)

For abstracts of individual papers see: 40296–40304, 40306–40313, 40341–40348, 40402–40413, and 40422.

40306 UTILIZATION OF DIGITAL COMPUTERS FOR CONTROLLING THE NUCLEAR POWER PLANTS AND TEST REACTORS OF THE CEA. Chapelot, A. (CEA, Paris). pp 17-27 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968. (In French).

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The commissioning of the G2 and G3 reactors at Marcoule in 1959 demonstrated the need for digital data processing facilities, including computers, for monitoring channel outlet temperatures and adjusting them to optimum values. Data-processing equipment was built and put into service, and has now proved its worth. The characteristic features of various projects involving computers connected with the CABRI, RAPSODIE and OSIRIS reactors and the EL 4 power plant are described. A description is given of the growing role of computers in the field of safety and automation in the C.E.A. projects. (auth)

40307 UTILIZATION OF DIGITAL COMPUTERS FOR CONTROLLING THE NUCLEAR POWER PLANTS OF THE EDF. Dive, P. (Electricite de France, Paris). pp 29-48 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968. (In French).

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

Designing the control system for the EDF 1 nuclear power station at Chinon in 1958, involved the problem of monitoring and processing a homogeneous set of more than 1000 variables (burst-slug detection). The possibility of using a digital computer was considered and selected from the possible options. A description is given of how computers came to be used for monitoring and control of the other power plants at Chinon (EDF 2, EDF 3) and at Saint-Laurent-des-Eaux and Bugey. The advances made possible by the rapid technical progress in digital systems are given. Mention is also made of the two similar projects in conventional thermal stations, stressing the important differences between the problems to be solved. (auth)

40308 ON-LINE COMPUTERS IN CENTRAL ELECTRICITY GENERATING BOARD NUCLEAR POWER STATIONS. Jervis, M. W. (Central Electricity Generating Board, Berkeley, Eng.). pp 51-78 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The limitations of conventional indication and control equipment for nuclear power stations and the advantages of systems using digital computers are brought up-to-date in the light of experience gained from systems now in operation and in the course of construction, with special reference to the Advanced Gas-cooled Reactor (AGR) stations. These factors include economic and staffing considerations, analysis of the type and extent of visual displays and permanent records required, and the design of special displays for assisting in fueling and channel-gagging operations in connection with the AGR. Due to the lack of sufficient previous knowledge in some areas concerning the use of computers, particularly that of the man-machine interface, it has been necessary to initiate some special investigations. These include optimum layout of alpha-numeric data in cathode ray tube displays, alarm display, processing and analysis and methods of achieving the best system configuration for high overall reliability at acceptable cost. In connection with the latter it is necessary to assess quantitively the expected system reliability in terms of continuity of service and relate this to that required by the operators to give economic station operation. Some managerial problems have arisen on the contracts and the CEGB policy in these matters is outlined. The facilities provided by the system at the Oldbury nuclear power station are described and operating experience is reviewed with special reference to computer processing and analysis of the station alarms and the reactions of the operators to the system. The Wylfa nuclear power station computer system is now being commissioned and only experience gained during this period can be reported. The systems for Dungeness "B" and Hinkley "B" are in the design and construction stages, so that no experience is available except on problems which have occurred during these stages. One significant advantage of the use of on-line computers in nuclear power stations is its development potential and some possible future lines of development are discussed. 13 references. (auth)

40309 PROCESS COMPUTER APPLICATION IN AEG DESIGNED BWR POWER PLANTS. Wolff, U. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). pp 105-21 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

Significant and direct economic gains resulting from the use of process computers with boiling water reactor nuclear power plants have led to their inclusion into AEG designed plants. Most of these gains come from the computer function of fast and accurate power distribution determination, thus providing the capabilities for further improvement of power distribution and fuel management strategy optimization. The basic logic and the physics methods applied to the solution of this task are discussed in detail, leading to definite conclusions with respect to design requirements for computer hardware and plant instrumentation. A brief description of these systems is given. Calculations based on physics models used in the process computer program system are compared to experimental plant data in order to check the quality of these physics models prior to the computer installation on the site. Additional computer functions which assist the operator in the evaluation of plant disturbances are touched upon briefly. Logic and methods required for the process computer program system design are appreciably different from those normally used in reactor design. The practical experience gained so far in the course of development and production of software systems for two plant applications (KRB and KWW) is presented. 3 references. (auth)

40310 COMPUTER CONTROL ON CANADIAN NUCLEAR REACTORS. Pearson, A. (Chalk River Nuclear Labs., Ont.). pp 123-44 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

Experience with digital computer control of nuclear power plants in Canada began in 1963 with an experiment on the NRU research reactor at the Chalk River Nuclear Laboratories. Information display techniques, self-testing procedures, and hardware priority interrupt system were developed. The Douglas Point Generating Station includes a digital computer in its control system with the new feature that direct digital control of some reactivity elements is done. As a result of the two experiences, several power reactors

now under construction will be computer controlled. A dual computer approach is being used in each case and the computer will exercise direct digital control over all reactivity mechanisms except the emergency shut-off rods. These computers are a vital part of each system and operation of the station will not be possible without at least one of the computers in service. The computer systems for two of the stations have been delivered and are now being programmed. 4 references. (auth)

40311 THE ON-LINE DIGITAL COMPUTER SYSTEM FOR THE DUNGENESS B NUCLEAR POWER STATION. Cameron, A. R. (Atomic Power Constructions Ltd., Sutton, Eng.). pp 273-300 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The Dungeness "B" Nuclear Power Station consists of two Advanced Gas-Cooled Reactors producing an output suitable for driving two 660 MW(e) turbo-generators. The major items of plant in the station are centrally controlled from a single control room. This is largely made possible by the use of a digital computer system and C.R.T. displays. Three digital computers employing microminiature techniques together with drum stores, scanners and other peripheral equipment are used to process a large number of analogue and digital signals from the plant. For the first time in the U.K., the computers are used directly in the control of the reactor, reactor start-up and main turbine and feed-pump turbine run-up. In addition, a comprehensive C.R.T. display system with a large variety of formats and alarm analysis enables the operators to be kept informed about the state of the plant at all times. One of the three computers is used for each reactor while the third is a common standby which is automatically brought into use in the event of a fault. The standby computer may also be used for various off-line functions such as fuel irradiation records. The development of software is progressing in parallel with design and manufacture. 3 references. (auth)

40312 TECHNIQUES OF COMPUTER APPLICATION FOR THE MARVIKEN NUCLEAR POWER PLANT. Akesson, J. (Aktiebolaget Atomenergi, Stockholm). pp 301-18 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The Marviken Nuclear Power Plant is being built on the shore of the Baltic Sea about 28 miles to the east of the town of Norrköping. The reactor is a boiling heavy water reactor with internal super-heating. The condenser is cooled by sea-water. It is a single cycle system with reactor steam going directly into the turbine. As Marviken is the first full-scale prototype of this kind being built, the degree of automation was investigated in detail and it was found that a process computer would be the best solution to get the necessary flexibility. Especially during start-up and during fuel changing under load there are so many operations which have to be done in the correct order and some of them also within narrow time intervals that it would be difficult to have this done by a human operator. The computer will also give more easy handling of the station, increased security and availability. 2 references. (auth)

40313 TASKS PERFORMED BY THE PROCESS COMPUTER IN OBRIGHEIM NUCLEAR POWER STATION. Pannewick, A. (Siemens-Schuckertwerke AG, Erlangen, Ger.); Pickel, E. pp 319-50 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The 300 MW(e) Obrigheim nuclear power station is equipped with a dual coolant loop pressurized water reactor. A process computer system is used as a complement to the electronic open- and closed-logs control systems and the protective and monitoring equipment. The basic functions, programs, and hardware of the process computer system are described. (H.D.R.)

Power Reactor Development

Refer also to abstracts 38068, 38073, 40386, and 40430.

40314 (CONF-690401) PROCEEDINGS OF CONFERENCE ON THE EFFECTIVE USE OF COMPUTERS IN THE NUCLEAR INDUSTRY, KNOXVILLE, TENNESSEE, APRIL 21-23, 1969. (Oak Ridge National Lab., Tenn. Tennessee Univ., Knoxville). 692p. Dep. CFSTI.

The various uses to which the third generation computer lends itself are discussed with particular application to reactors. Such diverse topics as reactor kinetics computations, data processing, multigroup calculations, reactor design systems, hybrid computations, computational techniques, engineering analysis, and Monte Carlo calculations are covered. Separate abstracts have been prepared for forty one of the forty two papers; the one extra paper by E. L. Wachspress appeared as USAEC Report No. KAPL-P-3803. (M.L.S.)

For abstracts of individual papers see: 38138–38140, 38159–38161, 38346–38348, 39523, 39860, 39903, 40091, 40315, 40332, 40333, 40366, 40386, 40387, 40414, 40424–40443, and 40455.

40315 (CONF-690401-, pp 369-90) HYBRID SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS IN NUCLEAR PLANT SIMULATIONS: A REVIEW. Vichnevetsky, R. (Princeton Univ., N. J.).

The types of problems related to nuclear power plants which are more easily solved by a hybrid digital-analog computer are delineated. Mathematical bases for the transient field problems arising in nuclear power plants, and the assumptions associated with solutions of these, are summarized; solution of associated boundary value problems are discussed. Applications of the hybrid systems are outlined. 57 references. (M.L.S.)

40316 (DOCKET-1154-1) BONUS: ORDER AUTHORIZING DISMANTLING OF FACILITY. (Puerto Rico Water Resources Authority, San Juan). Aug. 11, 1969. 8p. Dep. CFSTI.

40317 (GA-8662) HTGR BASE PROGRAM. Quarterly Progress Report for the Period Ending May 31, 1968. (Gulf General Atomic, Inc., San Diego, Calif.). June 28, 1968. Contract AT(04-3)-167. 192p. Dep. CFSTI.

FISSION PRODUCTS—behavior in HTGR systems, (E/T)
—sorption by graphite
—diffusion in graphite
GAMMA RADIATION—heating effects in HTGR materials, (T)
GRAPHITE—fission product diffusion in
—sorptive properties for fission products
—radiation effects on HTGR candidate materials
RADIATION—effects on HTGR graphite
REACTOR FUELS—reprocessing methods for HTGR type
—development of coated particle, for HTGR reactors
REACTORS, GAS COOLED—design parameters for 1000 MW(e) HTGR concept, development during March–May 1968
—radiation heating in HTGR materials, analysis of gamma, (T)
—fission product behavior in HTGR systems, (E/T)
—fuel recycle in HTGR type, reprocessing methods for
—physics of HTGR type, (E/T)
—fuels for HTGR type, development of coated particle
—materials for HTGR type, radiation effects on graphite
(M.L.S.)

40318 (NP-17868) NUCLEAR FUNDAMENTALS. (Politecnico di Milano (Italy). Centro Studi Nucleari E. Fermi). 1967. 299p. (In Italian). Dep.

An overview of the nuclear industry, its requirements and applications, and its role in the economic structure of Italy is presented. The thermodynamic cycles associated with reactors are discussed; flow diagrams are shown for the various types of cycles. Engineering aspects of the reactor fuel elements are discussed; the different types of fuel elements are described and the general equations used in evaluating physical phenomena which occur are given. Behavior of materials in a radiation environment is discussed; the materials which are considered in most detail are fuel, coolant, and moderator materials. (M.L.S.)

40319 (NP-17946) DECISION PROBLEMS IN CONNECTION WITH ATOMIC POWER PLANTS. Punhani, Amrit Lal (Tekniske Hoejskole, Lyngby (Denmark). Instituttet for Matematisk Statistik og Operationsanalyse). 1969. 223p. Dep.

Thesis.

Factors affecting choices of power plants such as site selection, capital conditions and investment, skilled personnel requirements, etc., are discussed. Mathematical models for investment and investment planning are given. Siting criteria are evolved; the use of reliability theory for evaluation of risk is considered. Release of activity to the atmosphere is discussed; the efficiency of the containment and filter system is evaluated. Dispersion of activity in the atmosphere and dose calculations are discussed. The basic mechanisms of nuclearly produced energy are considered. Radioactivity, decay rates, and half-lives are summarized; the radiation hazard from reactors is discussed. The fundamental mathematical concepts, applicable to reactors, are discussed. 52 references. (M.L.S.)

40320 BREEDER REACTOR. (to Westinghouse Electric Corp.). British Patent 1,151,678. May 14, 1969. Priority date Apr. 11, 1967, United States.

REACTORS, BREEDER—core for fast, description of orifice regulated flow multiple zone

REACTORS, FAST—core for breeder, description of orifice regulated flow multiple zone (D.C.C.)

40321 AEC AUTHORIZING LEGISLATION FISCAL YEAR 1970. PART 2. HEARING BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-FIRST CONGRESS, FIRST SESSION ON REACTOR DEVELOPMENT AND TECHNOLOGY PROGRAM APRIL 24, AND 25, 1969. Washington, D. C., Joint Committee on Atomic Energy, 1969. 774p. GPO $3.25.

40322 ANALOGOVOE MODELIROVANIE V YADERNOI ENERGETIKE. (Analog Simulator in Nuclear Power Engineering). Sidorova, I. I. Moscow, Atomizdat, 1969. 159p.

Examined are the main fields of atomic power engineering in which methods of modeling are used. Briefly presented are the principles of mathematical modeling of the main problems. Included are block plans and principal plans of models used in estimates, experimental work, and development of nuclear power plants. The book was intended for familiarizing engineers, scientific workers, and students, operating in the field of atomic power engineering, with the possibilities of methods of modeling applicable to nuclear energy equipment. 242 references. (MTOR)

40323 SUMMARY OF PRELIMINARY DESIGN STUDY OF PROTOTYPE FAST BREEDER REACTOR. Miki, Ryohei; Suzuki, Yoichi. Nippon Genshiryoku Gakkaishi, 11: 369-75(1969). (In Japanese).

The objective of the Japanese prototype fast breeder reactor project is to construct a mixed oxide fueled prototype fast breeder reactor of 200 to 300 MW(e) capacity through the application of domestic technology with the contribution of associated work in research and development. The purpose of the preliminary design study is to let the manufacturers design a prototype fast breeder reactor plant untrammeled by restrictive conditions, and to permit them to employ original ideas and concepts, which might eventually be adopted and incorporated in PNC's prototype reactor project. A brief summary of the result of this preliminary design study is presented, with schematic illustrations of the reactor structure, fuel handling system and steam generator constituting the different reactor plans submitted. (auth)

40324 PROBLEMS, IMPASSES, AND PARADOXES IN NUCLEAR ENERGY. Gibrat, R. Ind. Chim. Belge, 32: Special No., (Vol. 1), 709-16(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

The various technical, financial, political, and commercial aspects of the development and use of nuclear power are examined. Problems in analyzing the economic competitiveness of small nuclear plants and in evaluating nuclear fuel needs are discussed. The seeming impasse of which type of intermediate reactor is most worthy of development is illustrated. Paradoxes of the simultaneous existence of converters and breeders and the production of large stocks of plutonium are described. (H.D.R.)

40325 DESIGN, CALCULATIONS, AND TESTS OF THE BR 3/VULCAIN CORE. de Waegh, F. (Belgo Nucleaire, Brussels). Ind. Chim. Belge, 32: Special No., (Vol. 1), 747-51 (1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

Basic fuel element and configuration parameters are presented for the Vulcain test core. Experimental and calculational methods for determination of neutronics and thermo-hydraulic characteristics of the core are described, and some results are compared. (H.D.R.)

40326 THE BR 3/VULCAIN EXPERIMENT. Storrer, J. (Belgo Nucleaire, Brussels). Ind. Chim. Belge, 32: Special No., (Vol. 1), 744-6(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

Objectives of the test at power of a Vulcain core in the BR-3 reactor are described. These objectives include: (1) observation of the fuel performance to high burnup; (2) determination of the long life operating characteristics of the core; (3) testing of the heavy water circuits at high pressure; and (4) testing equipment such as the hydraulic mechanisms of the control rods. (H.D.R.)

40327 HISTORICAL ACCOUNT AND GENERAL ACCOMPLISHMENTS IN THE VULCAIN PROJECT, PROSPECTS FOR USE OF THE REACTORS AT LOW POWER. Maldague, P. (Belgo Nucleaire, Brussels). Ind. Chim. Belge, 32: Special No., (Vol. 1), 734-6(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

Objectives of the Vulcain Project in the development of small power reactors are described. The history of the project since 1959, including the introduction of a Vulcain core in the BR-3 reactor, is summarized. (H.D.R.)

40328 INDUSTRIAL IMPROVEMENT IN FAST POWER REACTORS. Van Dievoet, J. Ind. Chim. Belge, 32: Special No., (Vol. 2), 35-40(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.2).

The history of theoretical and technological development of fast breeder reactors is summarized. Some of the more important developments in fuel elements, cooling systems, and safety features are reviewed. (H.D.R.)

40329 CONSTRUCTION OF WATER-WATER POWER REACTORS IN USSR. Skvortsov, S. A. (Inst. of Atomic Energy, Moscow). Teploenergetika, No. 6, 4-6(June 1969). (In Russian).

Development of the water-water reactors in the USSR and the future aspects of their utilization in high-power nuclear electrical plants are discussed. 7 references. (R.V.J.)

Kinetics and Dynamics

40330 (ANL-7544) THE EFFECTS OF AN OVER-COOLED STAINLESS STEEL REFLECTOR ON THE EBR-II POWER COEFFICIENT. Smith, R. R.; Bump, T. R.; Cushman, R. A.; Hyndman, R. W.; Kirn, F. S.; Loewenstein, W. B.; Long, J. K.; Madell, J. T.; Persiani, P. J.; Wallin, W. R. (Argonne National Lab., Ill.). May 1969. Contract W-31-109-eng-38. 115p. Dep. CFSTI.

During a routine startup for EBR-II Run 25 on April 21, 1967, significant changes were noted in the basic behavior of the power coefficient. The magnitude of the integral power coefficient decreased by a factor of approximately two while the magnitude of the differential power coefficient in the midpower region decreased by a factor of approximately four. As the result of considerable analytical effort, the change in the power coefficient has been identified with thermomechanical deformation effects in a stainless steel reflector that was installed before the startup. Reversed thermal gradients in the outer row of the two-row reflector were manifested by mechanical action that, in turn, modified the power coefficient by restricting the normal outward "flowering" of the core at upper elevations while augmenting the normal inward bowing of fuel subassemblies at core midplane. The two effects, both nonlinear with respect to power, affected the power coefficient by decreasing the negative (flowering) component and increasing the positive (inward-bowing) component. 42 references. (auth)

40331 (BMwF-FBK-69-14) TRANSIENT BEHAVIOR OF A PRESSURIZED WATER REACTOR. Riedle, K. (Technische Hochschule, Munich (West Germany). Institut fuer Technische Thermodynamik). May 1969. 161p. (In German). Dep.

The transient behavior of a pressurized water reactor was described using the basic conservation laws for mass, energy and momentum, and the kinetic equations for neutrons. This system of coupled differential equations was solved by the method of finite differences on a computer (IBM 360/40), so that for an arbitrary perturbation function which forces the reactor to deviate from steady state, the response of the reactor can be calculated. 21 references. (auth)

40332 (CONF-690401-, pp 16-29) TART: AN LMFBR TRANSIENT ANALYSIS PROJECT. Stevenson, M. G.; Bingham, B. E. (Babcock and Wilcox Co., [Lynchburg, Va.]).

A computer program, TART, for analysis of dynamic characteristics of large LMFBR's is described. The point kinetics and diffusion equations, on which the neutronics part of the computation is based, are given. The thermal-hydraulics, feedback, and primary coolant loops and flow coastdown models, used for the calculation, are described. Typical data resulting from transient calculations for uniform and nonuniform ramp insertions are shown graphically. (M.L.S.)

40333 (CONF-690401-, pp 344-65) THREE DIMENSIONAL BWR SIMULATION. Crowther, R. L.; Petrick, W. P.; Weitsberg, A. (General Electric Co., San Jose, Calif. Nuclear Energy Div.).

The three dimensional boiling water reactor simulation and organization program (BWR) is described. Methods for input and program execution are described. Computer hardware and software requirements for the program are described. The nuclear and hydraulics models for the programs are described. Results of calculations are given; data are shown graphically. 11 references. (M.L.S.)

40334 (EUR-4278) DYN: A DYNAMICS PROGRAM FOR PEBBLE-BED REACTORS. Friedrich, K.; Infuehr, E.; Massimo, L. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Mannheim (West Germany)). Feb. 4, 1969. 66p. (In German). (THTR-80). Dep.

The DYN zero-dimensional programme (FORTRAN IV for IBM 360/40) was developed for the calculation of the dynamic behavior of reactors with spherical fuel elements. Since pebble-bed reactors may contain fuel elements giving widely differing burn-ups, and in addition may even contain different types of fuel element, the programme was compiled in such a way that the calculation can be performed with up to 20 different types of element. Consequently, the temperature feed-back to the reactivity and also the maximum fuel-element temperatures can be correctly determined within the framework of the zero-dimensional model. Besides the calculation of processes in which the reactivity, the cooling-gas throughput or the gas inlet temperature is given as a function of time, the simulation of control processes is also possible. Both short- and long-term processes can be studied. 5 references. (auth)

40335 EFFECT OF AXIAL REFLECTORS ON HEAVY-WATER GAS-COOLED REACTOR PARAMETERS. Hermansky, Bedrich (Faculty of Nuclear Science and Physical Engineering, Prague). Jad. Energ., 15: 220-5(July 1969). (In Czech).

A sharp coefficient of axial heat release is defined enabling the analysis of the axial distribution of heat sources from the point of view of maximum power of the fuel channel and under the assumption that the limiting factor is the maximum permissible temperature on the surface or in the axis of the fuel element. The effects of asymmetric arrangement of axial reflectors of different thickness on fuel channel power, the reflector savings, and the coefficient of unevenness of axial heat release are investigated. 3 references. (auth)

40336 THE START-UP AND SHUT-DOWN OF THE DOR PRIMARY COOLING SYSTEM OPERATED WITH POLYPHENYL COOLANT. Paryzek, Richard; Novotny, P. (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ., 15: 225-8(July 1969). (In Czech).

The startup and shutdown of the DOR type nuclear reactor is one of the main problems determining the engineering reliability of this reactor. Various methods of overcoming the transients in the facility operating with high temperature melting organic substances are reviewed. A method is described, which differs from the methods known up to present, to startup and shutdown the primary circuit of the Czechoslovak DOR reactor as a contribution to the solution of the problem. The heat transfer liquid flowing in the primary circuit has its melting point decreased at intervals to aid in startup and shutdown. 12 references. (auth)

40337 NUCLEAR REACTION RATES IN EBR-II IRRADIATED STAINLESS STEEL. Dudey, N. D.; Heinrich, Robert R.; Williams, J.; Madson, Allen A. (Argonne National Lab., Ill.). Nucl. Appl. Technol., 7: 35-43(July 1969).

Production rates (atoms/gram megawatt day) of ^{58}Co, ^{54}Mn, ^{55}Fe, ^{63}Ni, and ^{60}Co in EBR-II irradiated stainless steel are reported. These rates can be used as precise flux and fluence monitors in fast reactors when appropriate spectrum-averaged cross-sections are applied. Seven spectrum-averaged cross sections for the core and four spectrum-averaged cross sections at eight radial positions in EBR-II are also reported. The ratio of ^{54}Mn/^{55}Fe atoms produced from ^{54}Fe represents a sensitive spectral hardness indicator for fast reactor spectra. This study also indicates that in EBR-II the flux per megawatt measured at high power is the same as that measured at low power by other authors. Results show that a diffusion theory calculation provides a reasonably accurate representation of the flux in the core of EBR-II but overestimates the flux in the blanket region. 19 references. (auth)

40338 EFFECTS OF FISSION PRODUCTS ON PHYSICAL QUANTITIES ACCOMPANYING BURN-UP OF LARGE Pu-U FAST REACTORS. Tone, Tatsuzo; Nakagawa, Masayuki (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo), 6: 295-302(June 1969).

The effects brought by the presence of fission products on the effective multiplication factor k_{eff}, the Na-void reactivity, the breeding ratio, the fuel composition and kinetics parameters have been calculated as functions of burn-up for Pu-U fast reactor with 3,000 l core volume. The fission products sharply reduce k_{eff} and increase the positive values of the Na-void reactivity. Moreover, at a given burn-up, this effect of fission products on k_{eff} and Na-void reactivity is governed largely by the total amount of the fission products found accumulated at the time of observation, and is independent of the history of the material. The fission products hardly influence the transformation accompanying burn-up undergone by the ratio of Pu to ^{238}U atoms and by the isotopic composition of Pu. Similarly, the effect on the internal breeding ratio also is very small. The total breeding ratio increases gradually with accumulation of the fission products. The effect on the effective delayed neutron fraction β_{eff} is only slight, while that on the prompt-neutron lifetime l_p is appreciably larger. 25 references. (auth)

Control Systems

Refer also to abstracts 38246 and 38345.

40339 (AE-364) CONTROL ROD REACTIVITY MEASUREMENTS IN THE AGESTA REACTOR WITH THE PULSED NEUTRON METHOD. Bjoereus, K. (Aktiebolaget Atomenergi, Stockholm (Sweden)). 1969. 45p. Dep.

An extensive series of control rod measurements was made in the Ågesta reactor during the low power experimental period following the first criticality. The pulsed neutron method, comprising nearly 300 measurements, is described. The main objective was the determination of control rod reactivity worths for different rods and groups of rods, but some supplementary measurements were also made, e.g., a determination of the prompt neutron decay constant for the delayed critical condition and four different cores. The cores consisted of 20, 32, 68, and 140 fuel elements respectively, and measurements were made at room temperature and with the moderator level close to critical for each core, and for the 140-element core also with full moderator height and at the temperatures 140 and 215°C. Both fully and partly inserted control rod groups were investigated. The measurements at critical water level give directly the control rod reactivity worths, whereas those with full water height give the shut-down reactivity. A comparison was made between measured reactivity worths for a number of rod groups and those calculated with the HETERO code. Results are presented. 17 references. (auth)

40340 (ORNL-TM-2489) MSBR CONTROL STUDIES. Sides, W. H. Jr. (Oak Ridge National Lab., Tenn.). June 2, 1969. 43p. Dep. CFSTI.

A preliminary study was made of the dynamics and control of a 1000 MW(e), single-fluid MSBR by an analog computer simulation. An abbreviated, lumped-parameter model was used. The control system included a steam temperature controller and a simplified version of the MSRE reactor temperature control system. The results of the study indicate a need for a variable speed, secondary-salt pump for close control of the steam temperature. During severe transients, considerable care must be taken in designing the control system if freezing or overheating of the salts is to be avoided. 7 references. (auth)

40341 COMPUTER INSTRUMENTATION OF THE PROTOTYPE FAST REACTOR. McAffer, N. T. C. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 351-79 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The Prototype Fast Reactor (660 MW(t), 250 MW(e)) will produce physics and engineering information for the design and construction of future fast reactors of several times its power. The plant instrumentation consists of four main parts: (1) an on-line computer supervised data system for overall control of plant operation, (2) a number of manual control stations adjacent to plant items for start-up purposes, (3) a small number of back-up instruments to ensure safe shut-down in the event of data system failure and to monitor the rejection of decay heat, (4) an automatic protective system acting independently of other instrumentation to prevent public hazards. Some aspects of the instrumentation and the reliability of the system performance are discussed. (auth)

40342 COMPUTER EVALUATION OF REACTOR START-UP ALGORITHMS. Hassan, M. A. (Atomic Energy Establishment, Cairo); Azer, M. T.; Ghonaimy, M. A. R. pp 257-70 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

Optimal and sub-optimal start-up policies for reactors are examined. The following aspects will be considered: problem formulation, difficulties of solution, approximations aimed at reduction of complexity, and methods of control policy implementations. An example of a fixed structure controller for sub-optimal implementation is given and the deviations caused by the postulated approximations are evaluated using analog computer simulation. 5 references. (auth)

40343 HEURISTIC CONTROL ALGORITHMS AND CONTROL THROUGH LEARNING PROGRAMMES. Spinrad, B. I. (International Atomic Energy Agency, Vienna). pp 145-61 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

A human operator of complex equipment or systems employs a hierarchy of responses. These responses are governed by required procedures, experience and judgment according to observation of the system history and state through records, memory, and monitoring mechanisms. The complex of required procedures, records, memory and monitors contains a vast amount of information which is conveniently computerized. Computer control also permits an evaluation of the most likely state-function to draw upon very sophisticated calculations. It is recognized that this ability automates many items of operator function which have been previously classed under "judgment." The residue of judgment demanded of the operator is more vague, and focuses on questions of pattern recognition. The actions taken continue to rely on the operator's experience, which must not be confused with the memory of the computer system. There is still another, related way in which human intervention remains part of the automatic control process. This is the formulation of control algorithms. In spite of the low cost of modern computers, the amount of potentially useful information is so vast, and the possible data interactions are so complex, that we must resort to simplified models. The choice of models is a typical heuristic operation, which has so far remained a human function. Likewise, the selection of response of a large number of controllers represents a field of possibilities which can still only be narrowed by heuristic means. In both these areas (non-standard alarm and action, and rule formulation), it will probably be desirable ultimately to continue the machine-man replacement. The tool selected for investigation is the "learning program." Briefly stated, the computer is presented with a large field of possible responses to the state function and history of the system. At intervals it samples from the responses and applies one. Measures of successful or unsuccessful results are associated with each response, and a "score" is accumulated. By automatically selecting "high scorers" for repetitive trial and dropping "low scorers" from consideration, the machine continues to improve the quality of its responses. In principle, score may be correlated with state function so that selective responses to selective conditions can result. Additionally, correlation of scores between successive responses especially when the "test" interval is small, permits identification of favorable combined responses. A very simple application of this procedure is presented. This is the program used for the automation of reactor startup. Although the program was implemented on a computer, in which the reactor was simulated by a kinetics code, it could just as well have been performed on the reactor directly. The result of the learning process demonstrated that heuristic learning procedure can lead to useful operating rules. It is postulated that the use of learning programs acting upon a large array of responses can lead to control under normal circumstances which, although sub-optimal, is only slightly so; that this type of control is more adaptable to non-standard states than is optimal control; and that it is a suitable tool for experimental selection of control algorithms. 8 references. (auth)

40344 FUTURE DIRECTION OF COMPUTER CONTROL OF POWER REACTORS IN JAPAN. Hara, M. (Japan Atomic Energy Research Inst., Tokyo); Fujisawa, T.; Monta, K.; Takumi, K. pp 79-103 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

Two types of power reactor (fast breeder reactor and advanced thermal reactor) are being designed in Japan, while several reactors of proven types are under construction. A scheme for the direct digital control of the fast breeder is described. The application of an on-line computer to the advanced thermal reactor is discussed, and a hybrid simulator for the development of the computer control system is examined. (auth)

40345 ON-LINE DATA PROCESSING AND CONTROL OF REACTOR FACILITIES AT WINDSCALE. Leng, J.; Clark, A. C.; Smith, I. C. (United Kingdom Atomic Energy Authority, Windscale, Eng.). pp 739-52 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

A system is described which uses a modest sized computer in a multiprogramming mode both to service up to six on-line terminals and deal with the normal off-line background work. The computer is an IBM 360 model 30 with 64K eight bit bytes of main storage and three disk drives operating under a multiprogramming supervisor. Locally written programs service each on-line terminal and reside simultaneously in the main store with the off-line work. The system is very efficient as regards the time utilization of the computer, although a proportion of the main store becomes unavailable for problem programs. Two specific on-line applications are discussed, both in the nuclear reactor field. In one a link is employed to provide a rapid turn round in the complex analysis of reactor physics measurements for the zero energy research reactor HERO. The other uses a link for data recording and parameter surveillance in the Windscale advanced gas-cooled reactor. 3 references. (auth)

40346 COMPUTER CONTROL OF THE HALDEN BOILING HEAVY WATER REACTOR. Moen, H.; Blomsnes, B.; Oevreeide, M. (Organization for Economic Cooperation and Development, Halden, Norway). pp 647-67 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The research and development program being performed at the OECD Halden Reactor Project during 1967 to 1969 includes the development of computer control of the HBWR. The principal objective of this work is to study the feasibility of the application of an on-line computer to a power producing nuclear reactor. Therefore, a wide range of activities has been undertaken in order to conduct a thorough study of the most significant potential applications of an on-line computer. The technical approach for the different problems encountered and the experiences gained are described. 3 references. (auth)

40347 IMPACT OF NUCLEAR REACTOR CONTROL ON THE STRUCTURE OF COMPUTER SYSTEMS. Basten, R. G. (Allgemeine Elektricitaets-Gesellschaft, Konstanz, Ger.). pp 517-33 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

Recently the field of computer system structure was given impetus from a certain class of on-line control problems. These problems are characterized by the fact that high values or even human lives depend upon the uninterrupted operation of a computer system. "Graceful degradation" is the term used for an adequate reaction of the system; i.e., malfunction will never be able to cause a breakdown of the computer system as a whole, wherever it may occur within the configuration; only a certain decrease in its processing capacity or "throughput" rate will result. Several technological approaches would be applicable to ensure such a system behavior. A number of possible approaches are considered. As to the present state of the art, the most effective solution will be a "polymorphic" computer system based on a fully modular design. Its main features are: (1) The system does not comprise any "singular" component. (2) The system is aware of its own state. (3) The system is able to reconfigurate itself automatically. (4) The system is able to reorganize automatically programs affected by a possible malfunction of a system component. The impact of these requirements on basic structure and design of hardware and software is discussed, as well as the interdependence between system configuration and its effectiveness and price/performance ratio. (auth)

40348 PARTIAL CONTROL FOR THE RELIABILITY OF THE ESSOR REACTOR DURING STUDIES WITH THE DATA ACQUISITION SYSTEM. Leroy, A. (EURATOM-CCR, Ispra, Italy). pp 381-404 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968. (In French).

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The T.I.S. system (system designed to process monitoring data) coupled to the ESSOR reactor is principally responsible for performing the following functions: monitoring the characteristic parameters of the cooling circuits and tripping the necessary emergency devices (reduction of power, emergency shut-down);

monitoring the condition of measuring channels; verification of start-up conditions; failed fuel element detection; and data logging. The system components and operation are described. (auth)

Cooling Systems

Refer also to abstracts 38164 and 38351.

40349 (LA-4129) SODIUM LEAK STUDIES. Brainard, John P.; Kirkpatrick, Donald C. (Los Alamos Scientific Lab., N. Mex.). Mar. 6, 1969. Contract W-7405-eng-36. 10p. Dep. CFSTI.

Containment defects that can result in Na leakage are being investigated. Na leakage through stainless steel into air is analyzed. The problems of locating potential defects with He mass spectrometer leak tests are intensified by the fact that they can easily be obscured by water, oil, and surface oxidation. Under these H_2 conditions, treatment at high temperature under vacuum or H_2 is required for detection. He leaks as large as 10^{-4} atm cm^3/sec do not appear to be a problem in Na systems at 400°C. However, He leaks of this size and smaller do appear to be a serious problem at the temperature of 650°C. (auth)

40350 COOLANT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,402,257. Filed July 3, 1964.

A method is described for reducing the radiation-induced CO_2-graphite reaction in a CO_2-cooled, graphite-moderated reactor. The method comprises the addition to the coolant of a fluid paraffin hydrocarbon, containing 1 to 5 carbon atoms in a concentration of at least 50 ppM by volume. (NPO)

40351 STEAM-COOLED NUCLEAR REACTOR. Ritz, Ludolf (to Gesellschaft fuer Kernforschung mbH). U. S. Patent 3,448,007. June 3, 1969. Priority date Aug. 19, 1964, Germany.

A steam-cooled nuclear reactor is described with a cooling steam generator arranged in a common pressure vessel with the reactor core. The pressure vessel has an internal vertically extending duct for passing superheated steam into the steam generator to evaporate condensate. The steam generator and core are separated by a steam distribution header through which the superheated steam duct passes to feed superheated steam to the bottom of the steam generator. The saturated steam generated by interaction of superheated steam with condensate is delivered from the steam generator through the distribution header and fed back into the core for cooling. (Offic. Gaz.)

40352 STRUCTURAL DESIGN CRITERIA FOR PRIMARY CONTAINMENT STRUCTURES (PRESTRESSED CONCRETE REACTOR VESSELS). Rockenhauser, W. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Eng. Design, 9: 449-66(Apr. 1969).

Starting from a general design philosophy which derives the requirements for a primary containment structure from the characteristics of a power reactor system, specific structural design criteria are formulated. The general structural response of a PCRV to various loads, the types and combinations of loads to be considered, and allowable stresses for the various PCRV component parts are presented and related to allowable values used in more conventional technology. This covers principal stresses in the concrete, the effect of multiaxial stress fields, bearing and bond stresses, allowable stress values for prestressing steel, and non-prestressed reinforcement. Load factors for limit design evaluations and their significance are discussed as they pertain to predefined failure conditions. Comparisons are made between design criteria developed for PCRV's in Europe and criteria that are being formulated for such applications in the United States. 30 references. (auth)

40353 NUCLEAR REACTOR WITH LIQUID COOLING. Grass, Gunther; Kottowski, Heinz (to EURATOM). British Patent 1,157,938. July 9, 1969. Priority date Nov. 5, 1965, Germany.

NOZZLES—aerators for liquid metal cooled and water cooled reactors, description of core arranged spray
REACTORS, LIQUID METAL-COOLED—aerators for coolants of, description of core arranged spray nozzle or shaped
REACTORS, WATER-COOLED—aerators for coolants of, description of core arranged spray nozzle or shaped (D.C.C.)

40354 IMPROVEMENTS RELATING TO THERMAL INSULATION. Best, Arthur David (to Whessoe Ltd.). British Patent 1,158,026. July 9, 1969. Filed Mar. 30, 1967.

A form of thermal insulation is described which is suitable for the internal surfaces of nuclear reactors having stainless steel canned fuel elements, and which does not suffer from the disadvantages of the conventional laminated foil type of insulation. The insulation comprises a layer of formed units of insulating material, disposed side by side, with gaps between adjacent edges filled with fibrous insulating material which also forms a layer between the units and the surface to be insulated. The preformed units may comprise shaped containers filled with fibrous, powdered, or solid insulating material, or may be simple slabs of solid insulating material. The containers may be of sheet metal or woven material. The units may be bevelled, so as to partially overlap. The surface to be insulated may have spaced linear projections over which fibrous material is laid and held compressed. Anti-convective barriers may also be provided. Various alternative arrangements are described. (UK)

40355 USE OF CO_2 AS A WORKING HEAT TRANSFER MEDIUM IN A NUCLEAR POWER PLANT. Gokhshtein, D. P.; Verkhivker, G. P. At. Energ. (USSR), 26: 378-80(Apr. 1969). (In Russian).

The Odessa Technological Institute has been investigating the advantages of using CO_2 in power reactors since 1958. The efficiency of such reactors is 41.5% for the British CO_2 reactors, and can be increased to 45% by using CO_2 as the working fluid in both passes (replacing water by CO_2 in one of the passes). The reliability of the equipment is increased, since the reactor operates with a single fluid. Chemical purification of water is not required. There is a danger of reaction of CO_2 with metal or graphite on increasing the temperature above 750 to 800°C. A decrease in size of the turbines is accompanied by an increase in area of the heating surfaces by using CO_2 in place of water vapor in the second pass. A single-pass system can give an efficiency of 52%, but it is necessary to raise the pressure of CO_2 in the reactor of 200 atm. CO_2 can also be used as a heat transfer medium in fast neutron reactors. (TTT)

40356 WARMUP OF A MODEL OF AN ATOMIC POWER PLANT WITH NATURAL CONVECTION. Selivanov, V. M.; Sidorova, I. I.; Gorev, A. A.; Korkhaleva, T. C.; Shcherbakova, T. G.; Klychkova, V. P. (Inst. of Physical Energetics, Obninsk, USSR). Heat Transfer - Sov. Res., 1: No. 3, 29-38(May 1969).

Presented is a study of an analog-computer solution of a model of a steam generating atomic plant with natural convection in two-loops. The problem is divided into two parts. The first part considers the warmup from the beginning to the onset of boiling in the second loop. The second part considers the time interval between onset of boiling and attainment of nominal pressure in the second loop. The calculated results are analyzed and compared with experimental data. The mathematical model is found to yield satisfactory results. (auth)

40357 MEANS FOR POWER CONTROL IN NUCLEAR REACTORS. Hannerz, Kare; Sundqvist, Cnut; Skygge, Carl Goesta (to Allmaenna Svenska Elektriska Aktiebolaget). U. S. Patent 3,446,704. May 27, 1969. Priority date Mar. 31, 1966, Sweden.

Described is a working medium flow control system for power control of a boiling water reactor from which the steam generated is led to a turbine, condensed, and returned to the reactor. At least part of the feed water is ejected as the operating fluid through the nozzles of vertical jet pumps discharging into a distributing vessel connecting the fuel assemblies. A conduit from the distributing vessel to the feed water conduit is provided with a pump to give an increased flow of operating fluid, thereby permitting control of working fluid flow and consequently of the reactor power independent of the feed water flow. (Offic. Gaz.)

40358 NUCLEAR REACTOR SYSTEM WITH JET PUMP FLOW MEANS. Gluntz, Douglas M. (to General Electric Co.). U. S. Patent 3,445,335. May 20, 1969. Filed Aug. 9, 1967.

A nuclear reactor system including at least one jet pump having means for measuring flow therethrough is disclosed. Flow is measured by a pair of pressure taps, both of which are located downstream of the jet pump inlet opening. In a preferred embodiment, the two pressure taps are located in spaced series along the jet pump diffuser. (Offic. Gaz.)

40359 SUGGESTION OF DOSIMETRIC CONTROL OF THE PRIMARY CIRCUIT. Moravek, J.; Pietrik, I.; Vespalec, R. Bull. EGU, No. 3-4, 46-9(1968). (In Czech).

A system of controls of the coolant gas in the primary circuit of nuclear power plants, ensuring the measurement of the magnitude and movement of important activities in the coolant gas, is described. Special attention is paid to the control of the fission products of uranium. (auth)

40360 ACTIVATED CARBON AS AN ADSORBER IN THE SUSPENSION REACTOR. Van der Plas, Th. Atoomenergie Haar Toepass., 11: 111-12(Apr. 1969). (In Dutch).

The removal of non-gaseous fission products from a reactor is analyzed. These fission products, including rare earths and corrosion products, are adsorbed onto the suspended fuel. Preferential adsorption by activated carbon would make it possible to remove them with the carbon, without removing the fuel from the system. The carbon suspension was obtained by superficial oxidation (chemosorption; it is an excellent adsorbent for Eu(III) and La ions). Irradiation of the water caused oxidation of the activated carbon to CO_2 during the residence time of the carbon within the system. The possible solutions of the problem include: decrease of the residence time of the carbon in the reactor; increase of the amount of carbon; and development of a less easily oxidizable carbon. The problem has not yet been solved. (TTT)

40361 PROBLEMS OF TECHNOLOGICAL DOSIMETRY IN THE HEAVY-WATER CIRCUIT OF NUCLEAR POWER PLANTS. Kopec, J. Bull. EGU, No. 3-4, 49-51(1968). (In Czech).

Presented is a brief analysis of the technological dosimetry of the heavy water circuit of gas-cooled reactors and problems involved in their design—corrosion of the material, activity sources, activation of individual isotopes, and the settling of products on pipes. Criteria for the principal arrangement of the dosimetry and requirements to be met by the system for ensuring a reliable and safe operation of the installation are described. (auth)

40362 MEASUREMENT OF THE CONCENTRATION OF FISSION PRODUCTS IN THE PRIMARY CIRCUIT BY RECORDING DELAYED NEUTRONS. Moravek, J.; Kubik, I. Bull. EGU, No. 3-4, 51-6(1968). (In Czech).

A method for detecting delayed neutrons from the viewpoint of the measurement of the concentration of fission products in the primary circuit of a nuclear reactor is evaluated. A method for calculation of the sensitivity for the selected reactor type and concrete parameters of the coolant in the primary circuit is presented. (auth)

40363 CAVITY LINER, PENETRATION LINERS, AND CLOSURES OF A PRESTRESSED CONCRETE PRESSURE VESSEL FOR A GAS-COOLED POWER REACTOR. Peinado, C. O. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Eng. Design, 9: 467-78(Apr. 1969).

The design criteria of the PCRV cavity liner and the penetration liners and closures are discussed, including the requirements for anchoring the liners to the concrete and the closure design requirements. Materials of construction are identified including discussion of special impact strength requirements and neutron radiation effects. Construction consideration, including inspections, tests, and quality assurance employed during construction are identified. The application of these requirements to the Fort St. Vrain reactor is discussed. 7 references. (auth)

40364 EXPERIMENTAL WORK IN THE ENGINEERING PROGRAM RELATIVE TO THE VULCAIN MARK I REACTOR. Deliege, J. (Belgo Nucleaire, Brussels. S. A. Cockerill-Ougree-Providence, Seraing, Belg.). Ind. Chim. Belge, 32: Special No., (Vol. 1), 737-43(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

Aspects of research and development on the Vulcain reactor project are summarized. Components and systems described include the heat exchanger, the pressure vessel cap with penetrations, the pressurizer, and the system for purification of the primary coolant. (H.D.R.)

Fuels

Refer also to abstracts 37958, 38046, 38056, 38060, 38063, 38209, 38242, and 38946.

40365 (APDA-211) INTERIM REPORT ON PHASE II OF A PROGRAM FOR THE DESIGN AND DEVELOPMENT OF A PLUTONIUM CORE FOR DEMONSTRATION IN A FAST BREEDER REACTOR. [Period Covered], January 1-August 31, 1967. Shoudy, A. A.; Doyle, T. A. (Atomic Power Development Associates, Inc., Detroit, Mich.). 87p. Dep.

The plutonium fuel development program is intended to lead to the demonstration of a PuO_2-UO_2 core in the Enrico Fermi Reactor. Phase I consisted of preliminary design and development of the core. Phase II was to be detailed design and irradiation testing. Because of the Fermi meltdown incident, Phase II effort was restricted to reviews of the preliminary core design, hazards analysis, critical experiment data, and the irradiation programs. These reviews are summarized. (H.D.R.)

40366 (CONF-690401-, pp 611-30) ROBOT: COMPUTER PROGRAM TO SOLVE THE BOWING PROBLEM IN ROD-TYPE FUEL ELEMENTS (LWBR DEVELOPMENT PROGRAM). Urbaniak, John J. (Bettis Atomic Power Lab., [Pittsburgh, Pa.]).

Mechanisms causing fuel rod bowing in power reactors are described. A mathematical model to describe this bowing is formulated. Use of an iterative technique for computation of rod slippage at the supports is discussed. The deflection and thrust equations solved by the ROBOT program are given. Effects of rod curvature, externally applied forces and moments, internally generated thrusts, thermal expansion, thermal gradient curvature, and fuel-clad interaction are evaluated. (M.L.S.)

40367 (GEAP-5771) POWER REACTOR HIGH PERFORMANCE UO_2 PROGRAM. Progress Report Number 9, October 1, 1968-March 31, 1969. Ogawa, S. Y. (comp.) (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). Apr. 1969. Contract AT(04-3)-189. 71p. (EURAEC-2112). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The complete results of the hot-cell examinations performed on eight selected fuel rods, and of the thermal-hydraulic test performed on a 3 × 3, 9-rod mock-up of the 7 × 7 Advanced Performance Fuel assembly corners are presented. The performance of the fuel rods from the standpoint of operation with UO_2 incipient and moderate central melting was very satisfactory. Specifically, it was shown that the volume expansion of UO_2 melting was adequately accommodated by the design, and that the degree of melting that occurred corroborated the design predictions very well. The results of the examinations show that the failures appear to be strictly from causes external to the fuel rod and, especially, not a direct result of the centermelt operation. The evidence, particularly the incipient rod failure, suggests a localized cladding overheating with the high heat flux, crud deposition and unique thermal-hydraulic conditions downstream of the lateral spacing dimples on the corner angle all contributing in some manner not yet completely understood. The out-of-pile loop tests designed to investigate the failure mechanism did reveal a local, spot overheating phenomenon that could account for the failures through accelerated cladding corrosion over extended periods of operation. At this time, it appears prudent to avoid a firm conclusion since the local, spot overheating did not occur at exactly the same positions in the loop test as the observed in-pile cladding deteriorations, and extrapolations must be made from the idealized loop test conditions to the actual reactor environment. Since relatively high heat flux is one of the governing factors leading to the failures in the rods located in the unique bundle corner positions, the straightforward corrective action to avoid similar failures is to lower the power of these rods. The plan is to place very low power-producing rods (containing depleted UO_2) in the critical positions by rearrangement of rods within each assembly. Eight new rods with lower enrichment (2.44%) will be inserted as part of the correction. Fuel assembly D-50 (0.570 inch o.d., pellet UO_2 fuel) presently operating in the BRP core is a suspect failure, presumably from the same localized cladding overheating under the corner angle that affected the two Advanced Performance powder assemblies earlier. Examination of this assembly at the site is scheduled during the refueling shutdown starting on April 21, 1969. (auth)

40368 (RISO-M-900) PREDICTION OF BURNOUT IN THE MARVIKEN OUT-OF-PILE FUEL TEST-ELEMENTS USING THE HAMBO PROGRAMME AND THE BECKER BURNOUT CORRELATION. Cortzen, F. W.; Olsen, A.; Abel-Larsen, H. (Danish Atomic Energy Commission, Risoe. Research Establishment). May 28, 1969. 27p. (CONF-690614-1). Dep.

From Meeting of the European Two-Phase Flow Group, Karlsruhe, Germany.

The use of the thermohydraulic-subchannel program HAMBO and the Becker burnout correlation (with cold-wall effect) on the rather open Marviken heavy-water fuel test elements FT36a and FT36b predicts the burnout heat flux within ±10% and predicts the local burnout site in an excellent manner. The calculation presupposes a calculation of the local void distribution with a fitting of the void calculation and the mixing scaling factor. The Becker burnout correlation in the calculational environment of HAMBO shows a systematic mass-flow-dependent deviation of the predicted from the experimental burnout heat flux. 17 references. (auth)

40369 SMALL NUCLEAR REACTOR HEAT SOURCE. Balent, Ralph; Wetch, Joseph R.; Cohen, Emanuel Richard (to North American Rockwell Corp.). U. S. Patent 3,449,208. June 10, 1969. Filed Dec. 17, 1956.

A small nuclear reactor is described which consists of an assembly of multiple members. Each member consists of a solid

metal hydride moderator matrix and a fissionable material. Each member is enclosed in a hydrogen-impermeable lining and is cooled by flowing liquid metal. The reactor core is surrounded by a reflector. (Offic. Gaz.)

40370 ^{236}Pu CONTAMINANT IN ^{238}Pu PRODUCED IN POWER REACTORS. Topp, S. V. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Appl., 7: 139-43(Aug. 1969).

The utility of ^{238}Pu produced from ^{237}Np irradiation depends on the amount of ^{236}Pu present. Calculations of ^{238}Pu produced by the (n,2n) reaction on ^{237}Np indicate that light-water power reactors produce ^{238}Pu containing 10 to 20 times as much ^{236}Pu as that produced in the USAEC D_2O- or graphite-moderated plutonium production reactors, and the liquid metal fast breeders produce 300 to 400 times as much ^{236}Pu as the production reactors. 6 references. (auth)

40371 FUEL ELEMENT WITH A MEANS OF PREVENTING THE FLOODING. Iizima, Tokuji (to Hitachi Ltd.). Japanese Patent 1969-1396. Jan. 22, 1969. Filed Apr. 6, 1966.

In the boiling-water type reactor, at the time of loss-of-coolant, to cool the fuel elements water is sprayed over them. Then, because of the opposed directions of the flows of spray water and produced vapor, the flooding occurs within the fuel element. By the method proposed, this flooding is prevented, leading to good cooling of fuel elements. The fuel element is made up by several fuel rods enclosed in a cladding tube. Holes (not to prevent the coolant flow through the element considerably) are cut, at suitable locations, in the wall of the cladding tube. A thin pipe, one end of which leads outside the reactor core, is connected to this hole; the pipe is bent in the shape of U at the point of this joint, to prevent the inflow of spray water. The produced vapor is led outside through the hole and pipe. (NSA of Japan)

40372 ECONOMIC COMPARISON OF THE FUEL CYCLES OF VARIOUS NUCLEAR POWER PLANTS. Esclangon, P.; Panossian, J.; Prouillac, Ch. (Groupement Atomique Alsacienne Atlantique, Le Plesis-Robinson, France). Ind. Chim. Belge, 32: Special No., (Vol. 1), 763-6(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

The fuel cycles of advanced gas cooled reactors, boiling water reactors, and conventional graphite-gas reactors are compared. Cost factors considered include fuel element fabrication and reprocessing, fuel inventories, and fuel financing arrangements. The evolution of fuel cycle costs are projected to 1980. (H.D.R.)

40373 USE OF PLUTONIUM IN NUCLEAR REACTORS. Vanden Bemden, E. Ind. Chim. Belge, 32: Special No., (Vol. 1), 722-3(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

A brief description of the interest in the use of plutonium as a fuel in thermal and fast reactors is presented. There is a review of the different technical problems affecting its use and concerning which the study is in the course of development. (tr-auth)

Auxiliary and Emergency Systems

40374 (IDO-17300) PRESSURE RESPONSES OF PWR CONTAINMENTS: A PARAMETRIC ANALYSIS. Slaughterbeck, D. C. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). June 1969. Contract AT(10-1)-205. 28p. Dep. CFSTI.

CONTEMPT (a computer program for predicting the pressure-temperature response of a dry containment building to a loss-of-colant accident) was used to analyze pressure responses in containment buildings of large pressurized water reactors under a wide range of conditions and assumptions. The analysis provides quantitative information on the sensitivity of parameters for use in the safety evaluation of reactor power plants. The results show the importance of break size and heat transfer during the blowdown of the reactor vessel and show how the action of emergency core cooling systems and subsequent additions of energy control the response during the postblowdown period. Also, the results show that containment safety systems are required to operate after blowdown to limit the pressure to a value below the design pressure. 6 references. (auth)

40375 CONTAINMENT VESSEL CONSTRUCTION FOR NUCLEAR POWER REACTORS. Sulzer, Hans D. (to Stone and Webster Engineering Corp.). U. S. Patent 3,438,857. Apr. 15, 1969. Filed Mar. 21, 1967.

Several structural modifications for containment of water-cooled nuclear power reactors of the pressurized-water type are disclosed. Single and double shell configurations display a combination of structural advantages containing, in addition, chambers for suppression of excessive pressure due to accidental causes by means of condensation of the generated steam and vacuum producing apparatus for reduction of leakage. (Offic. Gaz.)

Operation and Economics

40376 METHOD OF OPERATING A NUCLEAR REACTOR. Lyons, Mark F.; Weidenbaum, Bernhardt (to United States Atomic Energy Commission). U. S. Patent 3,446,703. May 27, 1969.

A method of operating a nuclear reactor to achieve a high burnup of fissile fuel by removing a majority of the neutron-absorbing fission products from the reaction zone of the fuel element as they are created through central melting of the fissile fuel is described. (AEC)

Safety and Siting

40377 (BNWL-tr-29) MATHEMATICAL MODEL FOR DETERMINATION OF THE FAILURE PROBABILITY OF REACTOR COMPONENTS. Knecht, O.; Zeibig, H. Translated by Diana L. Davis (Battelle-Northwest, Richland, Wash.), from Atomwirt., Atomtech., 14: No. 2, 87-92(1969). 19p. Dep. CFSTI.

A mathematical model for determination of the failure probability of mechanically and thermally loaded components and systems is developed. This is made possible by the introduction of failure mechanisms which are independent of each other and which form the base of experimentally determinable mathematical interrelationships. A relationship between the failure probability and the safety factors is determined. Using this relationship one is able to calculate the necessary safety factors with given failure probabilities for a determined service life. The model is applied to components made of 10 CrMoNiNb 9 10-steel which has been subjected to the failure mechanisms creep and fatigue. 20 references. (auth)

40378 (CONF-671102-46) TORNADO DESIGN CONSIDERATIONS FOR NUCLEAR POWER PLANTS. Bates, F. C.; Swanson, A. Einar (Black and Veatch Consulting Engineers, Kansas City, Mo.). [nd]. 28p. Dep.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

Consideration of tornadoes in the general design of nuclear power plants is detailed; tornado probabilities (chances in 10^4) are shown for the whole U.S. The empirical model used to describe tornado effects and tornado movement in the Midwest is outlined. Effects of tornado-generated missiles and the analytical descriptions of these effects are given. Path width and path length exposure probabilities are shown graphically. (M.L.S.)

40379 (DOCKET-50231-35) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR: LICENSE APPLICATION. Safety Evaluation by Division of Reactor Licensing. Preliminary Safeguards Summary Report. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 16, 1965. 710p. Dep. CFSTI.

SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR—site for, preliminary safety analysis of
—containment systems for, preliminary safety analysis of
—core for, preliminary safety analysis of design for
—buildings and structure at, preliminary safety analysis of
—control system and instrumentation for, preliminary safety analysis of
—radiation protection and waste disposal at, preliminary safety analysis of
—testing and development programs for, preliminary safety analysis of
—startup and operation of, preliminary safety analyses of procedures for
—safety evaluation of (M.L.S.)

40380 VIBRATION TESTING AND EARTHQUAKE RESPONSE OF NUCLEAR REACTORS. Smith, Craig B.; Matthiesen, R. B. (Nuclear Energy Lab., Los Angeles, Calif.). Nucl. Appl. Technol., 7: 6-34(July 1969).

Vibration testing of nuclear reactors is discussed as a part of the determination of the response of such systems to earthquakes. The basic theory of vibration testing is presented along with a comparison of impulse, ambient, and steady-state testing. Steady-state tests provide a method of obtaining the complete dynamic

characteristics of a system and of selectively studying each of the components of the system; e.g., containment, steam-generator, pressure vessel, instrumentation, etc. Generally, both impulse and ambient studies do not provide as much detailed information while being less time consuming and creating less interference with other operations. A series of tests performed on the UCLA research reactor, the Carolinas Virginia Tube Reactor and the Experimental Gas-Cooled Reactor at Oak Ridge are used to illustrate the effect of the vibrations on instrumentation as well as the response of the reactor cores, fuel elements, biological shielding, steam generators, exhaust stacks, and the containment structures. The tests of the UCLA reactor included tests with the reactor at full power. The examples illustrate the complexity of the soil-structure-reactor system while also indicating the nature of the results which may be obtained with vibration tests. 24 references. (auth)

Power Conversion Systems

40381 ELECTRIC POWER GENERATING SYSTEM. Hodge, Ronald I. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,439,194. Apr. 15, 1969. Filed Feb. 19, 1965.

A power conversion system for a liquid metal-cooled fast power reactor is described. The system consists of a magnetohydrodynamic generator converted to the core metal vapor outlet. A condenser downstream of a flow regulating nozzle condenses the vapor and maintains a second and lower pressure. (Offic. Gaz.)

40382 INTERMEDIATE SUPERHEATING OF NUCLEAR POWER TURBINE GENERATOR OPERATING UNDER SATURATED STEAM CONDITIONS. Margulova, T. Kh. (Inst. of Power Engineering, Moscow). Teploenergetika, No. 6, 6-8(June 1969). (In Russian).

Performance of an intermediate superheater for saturated steam turbine generators in one- and two-circuit nuclear power plants is studied. It was found that the 1500 rpm turbines are best suited for high-power, steam-saturated turbines with initial pressure of 60 bar. (R.V.J.)

40383 SELECTION OF NUMBER OF REVOLUTIONS FOR STEAM-SATURATED TURBINES IN NUCLEAR POWER PLANTS. Troyanovskii, B. M. (Inst. of Power Engineering, Moscow). Teploenergetika, No. 6, 8-13(June 1969). (In Russian).

Studies were made of the influence of the number of revolutions on the efficiency and performance of a steam-saturated turbine generator for a nuclear power plant. It was found that slow-speed turbines of over 300 MW and 1500 rpm (with exhaust parameters identical to the higher speed turbines) are more reliable and economical than the generators with 3000 rpm. 21 references. (R.V.J.)

Research and Test Reactors

Refer also to abstracts 38307, 39064, 40092, 40305, 40306, and 40345.

40384 (AAEC/TM-499) A THEORETICAL STUDY OF THE USE OF THE REACTOR MOATA FOR LATTICE EXPERIMENTS ON HEAVY WATER MODERATED REACTOR SYSTEMS. Durance, G.; McCulloch, D. B. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar. 1969. 22p. Dep.

The construction of "driven" critical assemblies of typical boiling light water cooled (NSGHWR) and pressurized heavy water cooled (CANDU) heavy water moderated power reactor lattices in the reactor MOATA is in principle possible without alteration to the existing concrete shield. Driver lattice requirements for criticality of such mixed systems are investigated, and the reaction rates of a range of spectrum-sensitive neutron detectors in the central lattice cell of some feasible configurations are compared with those appropriate to the central cell of the corresponding single-region critical reactors. It is concluded that critical configurations could be constructed for either CANDU of NSGHWR type central lattices, and that neutron spectra in the central cell of such systems would approach those of the single region reactor sufficiently close to provide adequate experimental checks of calculated lattice reaction rates. However, the cost and effort involved, particularly for NSGHWR which would require both light and heavy water to be present as moderators, would probably be warranted only if there was a pressing need for experimental data not available from other sources. 7 references. (auth)

40385 (BNWL-998) STEAM COOLED FAST MODULE (SCFM). NEUTRONICS AND THERMAL HYDRAULICS. Lanning, D. D. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 3, 1969. Contract AT(45-1)-1830. 89p. Dep. CFSTI.

The general design of a steam cooled fast module for providing $\sim 2 \times 10^{15}$ φ_F in a research or test reactor test region 4 to 5 in. in diameter and 3 to 4 ft in length is described. Physics aspects of the module core are detailed; relationships between temperature, pressure, and smeared steam density are shown graphically. Neutron fluxes are shown for various fuel materials; power profiles are shown; cross sections of the module show control and coolant systems. Details of thermal-hydraulics studies are given; typical core design parameters are tabulated. Analytical calculations are compared with experiment. (M.L.S.)

40386 (CONF-690401-, pp 256-96) OPTIMIZATION OF THE DOPPLER EFFECT IN A FAST MATERIAL TEST REACTOR BY PROGRAMMING TECHNIQUES. Gandini, A.; Salvatores, M.; Sena, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)).

A method is described that adopts the generalized perturbation theory and programming techniques for optimizing reactor integral parameters, linear or bilinear with the real and adjoint neutron densities, after assumption of given constraints. An application of these methods to the optimization of the beryllium distribution with respect to the Doppler effect in a fast ceramic test reactor is shown. 10 references. (auth)

40387 (CONF-690401-, pp 415-32) HYBRID SIMULATION IN FFTF SYSTEM CONCEPTUAL DESIGN. Gunby, A. L.; Worth, Grant A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The computational models developed for hybrid simulation of the FFTF reactor and process systems are described. The development and descriptions of the models for components, reactor vessel, sodium systems, and heat transport systems are discussed. Results of model calculations are evaluated. (M.L.S.)

40388 (DOCKET-50112-1) UNIVERSITY OF OKLAHOMA RESEARCH REACTOR. License R-53; Organizational Changes for July 1, 1967-June 30, 1968. (Oklahoma Univ., Norman). June 10, 1968. 3p. Dep. CFSTI.

40389 (DOCKET-50112-2) UNIVERSITY OF OKLAHOMA RESEARCH REACTOR. License No. R-53, Amendment 5. (Oklahoma Univ., Norman). Oct. 24, 1968. 19p. Dep. CFSTI.

The Technical Specifications for the University of Oklahoma AGN-211 Research Reactor are listed. Record keeping and reporting requirements are delineated. The complete reactor license is included. (M.L.S.)

40390 (DOCKET-50243-1) OREGON STATE UNIVERSITY RESEARCH REACTOR. License No. R-106, Amendment 2. (Oregon State Univ., Corvallis). July 30, 1969. 6p. Dep. CFSTI.

The safety evaluation, pertaining to the increase in power level from 250 kW(t) to 1 MW(t) of the Oregon State University research reactor, is given. The TRIGA reactor will be operated in pulse mode with pulse insertions to be $4.00 reactivity maximum. (M.L.S.)

40391 (KURRI-TR-56) RESEARCH ON RADIOACTIVE DUST IN THE AIR AT KUR OPERATION. Negoro, Akihiko; Sekiya, Koichi; Maki, Hirotoshi; Tsujimoto, Tadashi; Yoshii, Giichi; Katsurayama, Kosuke (Kyoto Univ. (Japan). Research Reactor Inst.). [1968]. 6p. (In Japanese and English). Dep.

Investigations were carried out on the radioactive dust which might have been produced when KUR reactor operated. According to the results, the radioactive dusts produced in the course of operation of the KUR reactor may be divided into two kinds: the dust that may be originated from the fission production of the fuel; and the other, being the aerosols activated. The former, compared with the latter, is produced in greater quantity. Moreover, such a quantity appears to depend largely on the specific kind of fuel used and the time length of operation. 10 references. (auth)

40392 (KURRI-TR-57) REACTOR POWER MONITORING BY MEASURING ^{16}N AND ^{17}N ACTIVITIES IN PRIMARY COOLING WATER. Kimura, Itsuro; Atobe, Kozo; Shibata, Toshikazu (Kyoto Univ. (Japan). Research Reactor Inst.). [nd]. 21p. (In Japanese and English). Dep.

In order to monitor any power drift during long time operation of Kyoto University Reactor, KUR, ^{16}N and ^{17}N in the primary cooling water have been measured with a small NaI(Tl) scintillation counter and a BF_3 proportional counter, respectively. Since both ^{16}N and ^{17}N are produced by (n,p) threshold reactions of high energy neutrons, these power monitors hardly suffer from the effect of control rod shadowing, and burn up of fuel. Proportionality between the conventional power meter that is composed of a com-

pensated ionization chamber and a micro-micro ammeter and the concentrations of ^{16}N and ^{17}N is satisfactory from 1 kW up to 5 MW full power, especially the accuracy for ^{17}N is less than 1%. Both ^{16}N and ^{17}N count rates during long time operation at high power level have shown no drift, although all control rods have remarkably moved. By pursuing ^{16}N and ^{17}N count rate after reactor scram, reactivity worth of control rods has been obtained and the result is relatively lower than the value which is measured by the positive period method. Also, the speed or the flow rate of primary cooling water has been measured with the ^{16}N and ^{17}N monitor. 17 references. (auth)

40393 (LA-4192) 1969 STATUS REPORT ON THE OMEGA WEST REACTOR, WITH REVISED SAFETY ANALYSIS. Williams, H. T.; Stopinski, O. W.; Yarnell, J. L.; Lyle, A. R.; Warner, C. L.; Maine, H. L. (Los Alamos Scientific Lab., N. Mex.). May 29, 1969. Contract W-7405-eng-36. 74p. Dep. CFSTI.

The Omega West Reactor (OWR) is a thermal, heterogeneous, tank-type research reactor operated by the Los Alamos Scientific Laboratory. The reactor is light-water moderated and cooled, and utilizes Al-clad fuel elements of the Materials Testing Reactor (MTR) type. The OWR was originally operated at a power level of 5 MW thermal. In 1968, after 9 yr of operation at 5 MW, the normal operating power level was increased to 8 MW. At this level, the reactor provides fluxes of up to 8×10^{13} neutrons/cm^2-sec in the accessible experimental facilities. The OWR was designed primarily as a research machine, but it also serves as a test facility in support of the Laboratory's programmatic activities. The reactor, its auxiliary systems, and its mode of operation as of May 1969 are described. The operating history is covered, as well as the details of additions and modifications made since initial construction. Also included are the results of a recent 1-yr survey of the meteorological conditions at the reactor site. These results are combined with a revised model of the maximum credible accident to present a complete reevaluation of the extent of the possible accident hazards. It is shown that the OWR complies with the site requirements of 10 CFR 100. 37 references. (auth)

40394 (ORNL-TM-1532(Rev.2)) OPERATING SAFETY LIMITS FOR THE HIGH FLUX ISOTOPE REACTOR (HFIR) (100 Mw MAXIMUM POWER). (Oak Ridge National Lab., Tenn.). May 22, 1969. 15p. Dep. CFSTI.

The operating safety limits designate the limits within which the reactor can be operated safely. The limits specified were determined by design or experience. The limits are listed according to the functional components. One section indicates what limitations are placed on experiments, and another section specifies the limitation placed on administration of the operation. (auth)

40395 (RISO-M-792) ANALYSIS OF THE ACCURACY OF MEASUREMENTS OF REACTOR PARAMETERS BY AUTO- AND CROSS-SPECTRUM STUDIES. Teodosic, Vlada (Danish Atomic Energy Commission, Risoe. Research Establishment). Aug. 1968. 14p. Dep.

The analysis of variances of the periodogram estimators, as well as of the smoothed estimators, shows that the auto-spectrum method is equivalent to the cross-spectrum method in the case of equal detector efficiencies only if constant filter bandwidth is used to measure all regions of both spectra. If a relatively wide filter is used to measure the high frequency region of the auto-spectrum, the auto-spectrum method exhibits a slight advantage over the cross-spectrum method. In the case of unequal detector efficiencies the auto-spectrum method always offers a better accuracy than the cross-spectrum method. (auth)

40396 (TID-25139) LOW CYCLE FATIGUE TESTS ON ATR PIPING SYSTEM MOCK-UPS. Final Report. Lowenberg, A. L.; Norris, E. B.; Whiting, A. R.; Viaclovsky, S. (Southwest Research Inst., San Antonio, Tex. Dept. of Materials Engineering). Jan. 13, 1967. 53p. Dep. CFSTI.

For Ebasco Services, Inc., New York.

During an inspection of the primary coolant system for the Advanced Test Reactor, radiographs were made on part of the circumferential butt welds and the lap joint stub-ends. These radiographs revealed lack of penetration defects in some of the stub-ends. These radiographs revealed lack of penetration defects in some of the stub-ends and lack of fusion defects in some of the butt welds. A program to mock up and test 4- and 6-inch diameter joints and stub-ends with simulated defects was conducted. Low cycle fatigue tests were conducted on mockups with potential fixes. Results of the life cycles and strain range to failure tests are presented. (H.D.R.)

40397 MEASURED THERMAL NEUTRON FLUX PERTURBATIONS IN CYLINDERS IN A TEST REACTOR. Lynch, John H.; Peters, Lawrence E. Jr. (Lewis Research Center, Cleveland). Nucl. Appl., 7: 128-38(Aug. 1969).

In the design of irradiation experiments, prediction of the perturbation of the thermal-neutron flux by the experiment test specimens is frequently a problem. In order to obtain a model for calculating these perturbation effects, an experimental study was performed. A cylindrical shape was selected as being most typical of irradiation test specimens, and measurements of perturbation effects were made for several cylinders having different dimensions and made from different materials. Regression analysis was used to obtain polynomials from these measurements. These polynomials can be used to predict the flux perturbation, depression, and self-shielding factors as functions of cylinder materials and dimensions and control rod position. The polynomials include a wide range of sizes and materials so that almost any cylindrical specimen that might be found in a typical irradiation capsule can be evaluated. In general, the error at the fitted points was only a few percent over the range of variables corresponding to most common materials and dimensions. (auth)

40398 MEASUREMENT OF NEUTRON FLUX IN NUCLEAR REACTOR BY MEANS OF FISSION TRACK METHOD. Sakanoue, Masanobu; Nakanishi, Takashi (Kanazawa Univ., Japan). Nippon Genshiryoku Gakkaishi, 11: 332-9(1969). (In Japanese).

Measurements of thermal and fast neutron fluxes in a mixed radiation field have been carried out by etching technique applied to fission tracks on a mica detector. As fissionable material, use was made of electrochemical deposits—on Au-coated Cu-plate or stainless steel plate—of ^{232}Th, ^{231}Pa, natural U, depleted U, ^{233}U, ^{237}Np, ^{238}Pu and ^{239}Pu. The atomic density of the fissionable material on the plate was measured by α-spectrometry. These plates were placed in contact with muscovite mica, and exposed to neutron flux in a TRIGA Mark-II nuclear reactor, both with and without thermal neutron absorber of Cd. After the irradiation, the mica was etched by hydrofluoric acid solution, and the track density counted on a microphotograph. The values of the thermal and fast neutron fluxes were obtained from the mean cross-section of the fission reactions undergone by the different nuclides present. The resulting flux values showed reasonably good agreement with the values obtained by other methods. A discussion is given on the nuclear data obtained for several nuclides. A proposal is presented also on a simple and practical method for determining high track density by photometer with dark-field illumination. 19 references. (auth)

40399 PROCESS OF HOMOGENIZATION AND THE LATTICE-PARAMETERS OF A SUB-CRITICAL ASSEMBLY. Haroon, M. Rafiq (Georgia Inst. of Tech., Atlanta). J. Nucl. Sci. Technol. (Tokyo), 6: 338-40(June 1969).

The systematic variation of lattice parameters as a function of fuel-moderator ratio in a subcritical assembly (natural U, graphite moderated) has been investigated. Diffusion theory was used for correlation of results. The theoretical results were calculated according to the procedure laid down for graphite-moderated reactors based on the unit-cell concept of Wigner–Seitz. The results show that the method (Wigner–Seitz) predicts accurate results even when a fuel element is assumed to be spread over two lattices uniformly. This also proves the method of replacing a square lattice by an equivalent cylindrical one. The effect of voids (gas channels) on the lattice-parameters was also considered. 4 references. (auth)

40400 THERMAL NEUTRON ENERGY SPECTRUM OF JRR-3. Ishiguro, Yuji (North Carolina Univ., Raleigh); Ayao, Shinji; Hirata, Mitsuho J. J. Nucl. Sci. Technol. (Tokyo), 6: 341-3(June 1969).

Measurements of the energy spectrum of thermal neutrons emerging from the H-I horizontal hole of the JRR-3 reactor are described. A differential method is used in the energy region from 1.9×10^{-3} to 3.3×10^{-1} eV. Experimental apparatus is described and results are presented. 5 references. (auth)

40401 A REACTOR FACILITY FOR NEUTRON IRRADIATIONS AT TEMPERATURES RANGING FROM -193° TO 725°C. Chen, C. W.; Struss, R. G.; Crudele, J. S. (Iowa State Univ., Ames). J. Phys., E (London), 2: 746-8(Aug. 1969).

The installation and performance of a combined cryostat-flux converter system in a research reactor (CP-5 type) are described. The system is shown to be useful for fast neutron irradiations over a wide temperature range and to be adaptable for reactors other than the CP-5 type. (auth) (UK)

40402 ON THE TRANSIENT DIGITAL CONTROL OF THE HALDEN BOILING HEAVY WATER REACTOR. Ciechanowicz, W.; Solberg, K. O. (Organization for Economic Co-operation and Development, Halden, Norway). pp 239-55 of Application of

On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The compromise in the control strategy design to decrease the required number of computations was analyzed. Two types of HBWR control system models have been investigated; one involves the control strategy calculation for the overall dynamic system, in the other case the overall system has been split into two systems characterized by smaller number of state variables. The interactions between the split systems have been included by use of cross-coupling controller elements. The comparisons between considered control models have shown similar dynamic behavior of the investigated state variables. The main advantage of splitting the system is decreasing the order of state vectors taken into account in the control strategy calculations. The constraint problem has been considered by making use of Lagrange multiplier formalism and when the physical amplitude limitations are imposed on the controller signals. The comparison of both types of constraints has shown that the latter one is quite satisfactory simplification in constraint problem of the controller signals. The advantage of applying the physical limitation of the controller signal amplitude is that this type of constraint does not require the computer memory capacity for storage of the optimum trajectory space. 6 references. (auth)

40403 OPTIMAL XENON CONTROL AND THE RELATED PROBLEMS. Shinohara, Y. (Japan Atomic Energy Research Inst., Tokyo). pp 221-38 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The optimal shutdown control experiment on the heavy water reactor JRR-2 is described after a brief review of the optimal control theory for a simplified point reactor model. The experiment was performed in order to check the applicability of the optimal control based on such simplified models and the optimization was considered only with regard to Xe poisoning. For the convenience of the experiment, the time-minimal control with the specified value of post-shutdown Xe maximum was selected as the optimality criterion. The optimal power program was first obtained by applying Pontryagin's maximum principle. This theoretically determined program was then slightly modified for the convenience of reactor operation and monitoring. One of the problems which should be considered in the practice is the determination of state variables, namely, the values of Xe and I concentrations. Since these variables are not directly measurable, it is necessary to estimate them from the power history. Because an on-line computer was not available for this experiment, they were estimated by using some pre-calculated trajectory diagrams. The experimental results show that the optimal control based on the point reactor model can be applied to the JRR-2 with sufficient accuracy. The problems related to the application of on-line computers are also discussed. 14 references. (auth)

40404 APPLICATION OF TIME OPTIMAL CONTROL FOR DIRECT DIGITAL CONTROL ALGORITHM OF TTR. Monta, K.; Fukutomi, S. (Nippon Atomic Industry Group Co., Kawasaki, Japan). pp 191-219 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The theory of time optimal control and Liapunov's direct method for stability are applied to synthesis of a control algorithm for the TTR digital computer control system. In view of the use of reactivity as a variable representing the state of reactor system, a method has been developed that permits simple and accurate on-line calculation of the reactivity from changes in reactor power. Discussion is presented on some considerations required in realizing the results envisaged on the basis of a simplified model of the system. The control is determined in the whole phase plane as feedback control, and is programmed with the use of appropriate simplifications and approximations. Experiments were first performed on a simulated system of the reactor and then on the actual reactor system. The results described cover experiments on steady state performance as well as transient performance. 9 references. (auth)

40405 APPLICATION OF MODERN CONTROL THEORY TO DIGITAL CONTROL OF HBWR. Grumbach, R. (Organization for Economic Co-operation and Development, Halden, Norway); Bjoerlo, T. J.; Josefsson, R.; Bruaroey, P. G.; Solberg, K. O. pp 165-89 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

In the course of the development of an on-line digital control system for the HBWR plant, two separate lines have been followed. The first one is similar in principle to the conventional concepts of PID-control, and consists essentially of a conversion of the original HBWR analogue control system into a direct digital control (DDC) system. In the second approach, control strategies are being developed which are based on the techniques of modern control theory that were worked out especially for computer applications. This approach, including the results of direct control experiments carried out so far with these methods, is reviewed. 9 references. (auth)

40406 THE ON-LINE TEMPERATURE CONTROL SYSTEM AT THE SWISS REACTOR DIORIT. Bossel, J. B. (Swiss Federal Inst. of Tech., Zurich); Haelg, W.; Ryser, H. pp 857-76 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

An on-line system to survey the cooling channels of the fuel rods at the reactor DIORIT is described. The installation integrates into a general data handling system built around a digital computer. This general system is primarily used for data acquisition and reduction and control purposes of several neutron scattering experiments conducted by a team of scientists of the Federal Institute of Technology. The temperature monitor connects 260 points of the DIORIT with the computer. 5 references. (auth)

40407 AN ON-LINE COMPUTER SYSTEM FOR ANALYSING THE PROPERTIES OF THE VERA AND VIPER FAST REACTORS. Weale, J. W.; Benjamin, P. W.; Dalby, L. J. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 839-55 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

A Ferranti Argus 400 computer has been in use with the VERA and VIPER fast reactors since June 1967. The computer has a 2 μ sec 8096 word memory with a word length of 24 bits. It was developed for process control applications and has 8 interrupt connections which allow it to be used with a range of peripheral equipment associated with the two reactor programs. Each peripheral can be given direct access to the computer store; permanent storage is provided in the form of a paper tape system. (auth)

40408 EXPERIENCE IN DESIGNING AND OPERATING COMPUTER CONTROLLED REACTOR FACILITIES. Driver, G. E. (Battelle-Northwest, Richland, Wash.). pp 669-79 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

The problems which are encountered in applying digital computers to reactor data acquisition and control are described. Equipment and programming costs are treated, along with the unusual requirements for the design and installation schedule. Operator acceptance of new modes of process communication is discussed. One of the facilities used to illustrate the problems is the AEC's High Temperature Lattice Test Reactor (HTLTR) at Richland, Washington, which completed its first four months of full operation in March 1968. Except for the initiating of control rod movements, the HTLTR is under automatic control by a digital computer in all modes of operation including startup and shutdown. All control point data and alarms are displayed for the operator on a three-color cathode ray tube in alpha-numeric form. (auth)

40409 EXPERIENCE ACQUIRED IN THE USE OF ON-LINE COMPUTERS FOR THE SAFETY OF THE FAST REACTOR RAPSODIE. Gourievidis, G. (CEA, Paris). pp 597-620 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968. (In French).

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

RAPSODIE, at Cadarache, is a sodium-cooled fast-breeder reactor incorporating two C.I.I. digital computers. The place of the centralized data-processing system in the control of the RAPSODIE reactor, the objectives it set out to reach are described. Two sections are devoted to changes made in the initial analysis during

static periods (prior to start-up) and dynamic periods (power operation) of the RAPSODIE reactor, the methods used to overcome these various difficulties and the resulting practical considerations. (auth)

40410 COMPUTER CONTROL OF RESEARCH REACTORS AND OPERATING EXPERIENCE IN JAPAN. Takumi, K. (Hitachi Ltd., Tokyo); Takamatsu, S.; Fujisawa, T. pp 567-95 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

Three examples of the computer control of research reactors in Japan are presented. In designing a computer control system of the JRR-1 for an experiment to automate the start-up and power level change, emphasis was placed on the determination of sampling-rate. Assuming linearized configurations of the power and period control systems, a brief description is given of the dependence of the critical loop gain and integral square error on the sampling-rate. TTR computer control system consists of an alarm scanner and a main computer with about 15,000 words magnetic drum memory. Automatic reactor operation is one of the main functions of the computer. Five levels of priority interrupt are used. These are assigned for (1) post-scram job, (2) reactor power control, (3) alarm monitoring, (4) data logging, and (5) initiation of reactor power change. For reactor start-up, two start-up counter systems are used. A feasibility experiment for a fully automatic operation of the HTR was made, employing a digital computer control system. The system consists of a small control computer, an input-output peripheral, 3 BF_3 counters, and a control rod mechanism driven by a pulse motor. The results of start-up experiments of the HTR showed good agreement with those obtained from both the models of digital and analogue types. The optimum start-up control of the analog model is described in phase-plane diagrams. 3 references. (auth)

40411 AN EXPERIMENTAL COMPUTER-CONTROLLED INSTRUMENTATION SYSTEM FOR THE RESEARCH REACTOR DR2. Goodstein, L. P. (Atomic Energy Commission, Risoe, Denmark). pp 549-66 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

A process instrumentation system which incorporates a small digital computer has been developed for use at the research reactor DR2. This system is intended to serve as a test vehicle which will permit investigations in various areas of interest to be made by technical and operations groups. These include system configuration studies, man-machine communications, reliability and safety, closed loop control, display studies, etc. The digital system is run in parallel with the existing conventional instrumentation and an ultimate goal is to replace the latter with a modern computer-controlled system. A description of the system hardware and software with emphasis placed on those points and details which are felt to be of most interest is presented. 2 references. (auth)

40412 UTILIZATION OF THE DIGITAL COMPUTER FOR CONTROL OF THE CABRI TEST REACTOR. Delchambre, Ph. (CEA, Paris). pp 503-14 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968. (In French).

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

CABRI is an experimental swimming pool reactor using natural water and having an enriched uranium core. This reactor is designed for studying reactor safety and the behavior of reactors in transient states. Taking into account the large number of measurements which have to be made in a very short time, and the need to perform complex, rapid and varied experimental sequences, a transient measurement and monitoring unit was installed, operated by a type 350 digital computer. The consequences of using this digital system on the operation of the CABRI experimental reactor are described. (auth)

40413 THE APPLICATION OF AN ON-LINE DIGITAL COMPUTER TO THE CONTROL SYSTEM OF THE HIGH FLUX ISOTOPE REACTOR (HFIR). Bullock, J. B.; Danforth, H. P. (Oak Ridge National Lab., Tenn.). pp 459-78 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

A process control computer was combined with the existing HFIR analog control system to perform the function of limiting the shim-rod reactivity additions as well as direct shim-rod symmetry control. The automatic shim control is supervised by a computer program which uses the measured reactor power level to continuously compute the core reactivity requirements during the 23-day fuel cycle. The high power density (4 MW/liter) in the HFIR requires that flux tilting be controlled to minimize the possibility of hot-spot formation. This is accomplished by limiting the difference in shim-rod positions for reactor operation above 10 MW. The rod symmetry is controlled by a program that actuates rod control relays in the analog system in response to the asymmetry determined from shim-rod position sensors. The HFIR is described to serve as a basis for subsequent discussions of the detailed interaction of the computer with the conventional analog control system. 7 references. (auth)

Rocket and Space Reactors

40414 (CONF-690401-, pp 133-42) THIRD GENERATION COMPUTER USED TO CONTROL FUEL ELEMENT ASSEMBLY. Cort, G. E.; Agosti, R. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.).

An example of the use of third generation computers to control the assembly of fuel elements in a nuclear reactor is given. Through a combination of engineering calculations and a business type data handling system to provide checking and quality control monitoring, an individual set of assembly instructions is produced for each unique fuel element. The result is an optimized thermal performance for each solid graphite enriched uranium fuel element which operates within narrow limits of the average core temperature. Many fuel elements with up to a hundred different detail drawing configurations are used in each reactor. Approximately fifty different input quantities are needed to describe each element. These data are stored on four different magnetic tapes with public READ access, but WRITE access restricted to four different functional groups responsible for processing and updating the information on its own tape. The program uses these four controlled access tapes as input for the engineering calculations, for verifying that all elements were properly inspected and released, and for monitoring the assembled reactor against the planned design configuration. (auth)

40415 STABILITY STUDIES OF IN-CORE THERMIONIC REACTOR CONCEPTS. Brehm, R. L.; Hetrick, D. L.; Schmidt, T. R. (Univ. of Arizona, Tucson). Nucl. Appl., 7: 117-27(Aug. 1969).

The stability requirements of in-core thermionic reactor concepts are examined analytically utilizing an approximate two-region description of the fueled diode. General stability requirements for the model are derived and then evaluated for possible ranges of design considerations with regard to operating power density levels, diode dimensions and materials, and fuel materials. The stability of this type of reactor is shown to be only weakly dependent on design considerations provided the static power coefficient is negative. A comparison between the approximate stability criterion and the corresponding criterion obtained from a detailed analog computes simulation of a specific reactor concept indicates the approximate criterion is conservative. 13 references. (auth)

40416 THERMAL BLEACHING OF COLOR CENTERS IN γ-IRRADIATED KBr CRYSTALS. Kowalczyk, J. (Inst. of Low Temperature and Structure Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 17: 181-4(1969).

The role of ionic processes in the thermal bleaching of color centers in KBr crystals as received or plastically deformed and irradiated by γ rays was investigated. The crystals were heated after irradiation at various temperatures between 80 and 180°C. The activation energy was found to be 1.65 ± 0.05 eV per F center, pointing to the ionic character of the process. Deformation of the samples performed prior to coloration was found to cause a distinct drop in the rate of bleaching, suggesting that the mean free path for the diffusing entities responsible for the disappearance of F and V centers, increases with the deformation. Plastic deformation performed after coloration caused a rise of the bleaching rate. (D.H.M.)

Process Heat and Desalination Reactors

40417 CHEMONUCLEAR REACTORS. Juppe, Gottfried (Joint Research Centre, Ispra, Italy). Euro-Spectra, 8: 39-45(June 1969).

The possibilities of using the energy liberated by the fission of reactor fuels to excite and ionize chemical molecules and to break chemical bonds are examined. The conditions necessary for an efficient chemical reaction system are described, and the three problem areas involved in the development of a chemonuclear reactor, namely fuel development, decontamination of the chemical product, and economics, are discussed. (H.D.R.)

Marine and Portable Power Reactors

40418 (DOCKET-50238-48) N. S. SAVANNAH: LICENSE NO. NS-1, AMENDMENT 5. Technical Specifications Change No. 4. (First Atomic Ship Transport, Inc., New York). Aug. 4, 1969. 103p. Dep. CFSTI.

Revisions of the record keeping and reporting requirements of the Technical Specifications for the N. S. Savannah are given. The complete license for the Savannah is included. (M.L.S.)

40419 (HIT-329-R(Vol.1)) PM PLANT INTERFACE STUDY, TYPE 4 CORE. VOLUME I. (Hittman Associates, Inc., Columbia, Md.). Mar. 19, 1969. Contract W-7405-eng-26; Subcontract No. 2900. 64p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

The Type 4 replacement core for the PM-1 and PM-3A plants uses low enrichment UO_2 fuel instead of the fully enriched cermet fuel used in previous cores. The Type 4 core fits within the physical envelope dimensions of previous PM cores but is heavier. Its weight is 3250 pounds; the Type 2 core weight was 1685 pounds. The additional weight required investigation of all the refueling tools, refueling systems and core component removal equipment for structural adequacy. In addition, since the Type 4 core has different thermal design characteristics, decay heat removal in the spent fuel tank was investigated. The analyses and redesign, where required, of each component in the refueling sequence are described. Stress analysis results and recommendations and final design assembly drawings for each component requiring modification are presented. 8 references. (auth)

40420 (HIT-329-R(Vol.2)) PM PLANT INTERFACE STUDY, TYPE 4 CORE. VOLUME II. (Hittman Associates, Inc., Columbia, Md.). Mar. 19, 1969. Contract W-7405-eng-26; Subcontract 2900. 190p. Dep. CFSTI.

For Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.

Stress analyses for the recommended modifications of PM-1 and PM-3A equipment to accommodate Type 4 cores are presented. A specification for a 3 ton auxiliary crane is included. 11 references. (auth)

40421 NAVAL NUCLEAR PROPULSION PROGRAM, 1969. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-FIRST CONGRESS, FIRST SESSION, APRIL 23, 1969. Washington, D. C., Joint Committee on Atomic Energy, 1969. 251p. GPO $1.00.

Production Reactors

40422 ON-LINE COMPUTERS AT THE SAVANNAH RIVER PLANT. Gimmy, K. L. (E. I. du Pont de Nemours and Co., Aiken, S. C.). pp 727-37 of Application of On-Line Computers to Nuclear Reactors. Paris, Organization for Economic Co-operation and Development, 1968.

From Seminar on the Application of On-Line Computers to Nuclear Reactors, Sandefjord, Norway. See CONF-680917.

On-line digital computers are used to improve operating safety and efficiency of large production reactors at the Savannah River Plant. About 3250 analogue sensors are scanned; signals and computed results closest to limits are displayed to the reactor operator. Automatic alarm programs identify an exceeded limit, a change in the normal fuel-coolant temperature distribution, or a failed sensor. Temperature graphs and flux curves are used to optimize power distribution within the reactor. On-line diagnostic and recovery techniques are used to minimize computer downtime. (auth)

Reactor Theory

Refer also to abstracts 38936, 38937, 39914, and 40278.

40423 (AAEC/E-197) SOLUTION OF THE MULTIGROUP COLLISION PROBABILITY EQUATIONS. Doherty, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr. 1969. 10p. Dep.

A method is presented for the solution of the multigroup collision probability equations arising in reactor physics calculations. The method is a block relaxation scheme, involving the direct solution by inversion of the equations for a single group, and it has the conceptual advantage over the successive over-relaxation method that problems without upscatter, which are of interest in fast reactor design, can be solved without inner iteration. (auth)

40424 (CONF-690401-, pp 3-15) REVIEW OF COMPUTATIONAL METHODS FOR SPACE-TIME KINETICS. Henry, A. F. (Massachusetts Inst. of Tech., Cambridge).

Approximation techniques for reactor problems are discussed with reference to computer processing. The few group diffusion theory model is outlined. Methods used in solving the space-time equations are described briefly; these include: finite differencing, time synthesis, and space-time synthesis. 22 references. (M.L.S.)

40425 (CONF-690401-, pp 30-50) COUPLING OF DYNAMICS CALCULATIONS IN THE FREADM CODE. Freeman, D. D.

The FREADM computer code for fast reactor accidents and excursions analysis is described. The calculational model for the code is summarized. The use of time step control to couple the various dynamic models is detailed. Schematics of transient calculation logic are shown. Results of calculations for a sample test problem are presented in graphic and tabular form. (M.L.S.)

40426 (CONF-690401-, pp 51-4) FAST REACTOR ACCIDENT STUDY CODE, SAS1A. Fischer, G. J.; Carter, J. C.; Heames, T. J.; MacFarlane, D. R.; McNeal, N. A.; Sanathanan, C. K.; Sha, W. T.; Youngdahl, C. K. (Argonne National Lab., Ill.).

Capabilities and limits of the SAS 1A fast reactor accident analysis code are outlined. The program is written in modular form in FORTRAN IV, and can be used on either the CDC 6600 or IBM 360. The four driver programs to be used with the primary program are described briefly. The principal, or most important, subroutines are summarized. (M.L.S.)

40427 (CONF-690401-, pp 55-75) ON THE SOLUTION OF THE TIME-DEPENDENT GROUP DIFFUSION EQUATIONS BY AN IMPLICIT TIME DIFFERENCED ITERATIVE METHOD. Yasinsky, J. B.; Hageman, L. A. (Bettis Atomic Power Lab., [Pittsburgh, Pa.]).

The two-dimensional space-time differencing method used in the TWIGL program is discussed. The space-time diffusion equations which are solved by the program are given. Use of the cyclic Chebychev polynomial method for solution to the space-time equations is discussed. A numerical example is detailed; results of calculations are presented in graphic and tabular form. 11 references. (M.L.S.)

40428 (CONF-690401-, pp 76-101) NUMERICAL SOLUTION OF THE TWO-DIMENSIONAL TIME-DEPENDENT MULTIGROUP EQUATIONS. McCormick, W. T. Jr.; Hansen, K. F. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering).

A numerical algorithm for the solution of the two-dimensional time-dependent multigroup neutron diffusion equations is presented. The method assumes that the variation in the neutron flux at each mesh point can be represented as an exponential function of time over each integration time step. Additionally, the assumption is made that the transverse leakage in one spatial direction can be approximated by a pointwise transverse buckling over one time step. These assumptions together with an appropriate factoring and integration of the matrix form of the semi-discrete multigroup equations produce a mathematically consistent approximation and an unconditionally stable algorithm. It is also shown, for the special case of a constant step change in reactor properties, that the asymptotic numerical solution is proportional to the asymptotic eigensolution of the semi-discrete multigroup equations. The experimentally observed truncation error is discussed and several numerical experiments are presented which illustrate the accuracy and utility of the method. 11 references. (auth)

40429 (CONF-690401-, pp 102-15) NUCLEAR REACTOR SPATIAL KINETICS CALCULATIONS. Buffoni, G.; Galati, A.; Loizzo, P.; Lopez, S.; Norelli, F.; Pepino, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)).

The KINEX and ALADINO codes are described. The codes compute the dynamic response of a water cooled reactor to a control

rod-induced reactivity input. The KINEX code solves the linear neutron kinetics using the metastatic method; the ALADINO code performs the dynamic response calculations for a given system to the reactivity perturbation. Results of zero power transfer function calculations, using the ALADINO code, are tabulated; the thermohydraulics problems solved by the codes are described. Results of calculations for a sample problem, using the EBWR at high power, are given; data are shown graphically. 10 references. (M.L.S.)

40430 (CONF-690401–, pp 119-29) SOME THOUGHTS ON AEC FUNDED CODING. Hannum, W. H.; Lewellen, J. W. (Division of Reactor Development (AEC), Washington, D. C. Reactor Physics Branch).

Computational capabilities available to the reactor community are summarized. Coordination of code development efforts for reactor analyses is discussed; advantages and disadvantages are analyzed. The task of the recently created ad hoc committee for establishing standard code interfaces is outlined. Objectives of reactor code-development coordination are discussed. 35 references. (M.L.S.)

40431 (CONF-690401–, pp 193-207) NOISY1: A PROGRAM FOR CALCULATION OF SPACE DEPENDENT AUTO AND CROSS SPECTRAL DENSITIES IN REACTORS. Sheff, James R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Numerical analysis of the space-dependent auto and cross spectral density functions for bare cubical reactors is discussed. The NOISY1 computer code, which solves the spectral density functions and neutron detector efficiency equations, is described; the equations and flow diagrams for the program are included. The various features of the NOISY1 program are outlined; subroutines and operation modes are described. The program is written, primarily, in FORTRAN IV for the Univac 1108; however, several unique features of FORTRAN V are included. (M.L.S.)

40432 (CONF-690401–, pp 211-33) APPLICATION OF THE BLOCK INVERSION TECHNIQUE TO MULTI-DIMENSIONAL REACTOR CALCULATIONS. Wagner, M. R.

Use of the block inversion technique to obviate the use of reconditioning transformations is discussed. Block inversion is based on initial value treatment, since the flux is expanded at inner mesh points such that the given boundary conditions are satisfied for the homogeneous solution; an iterative technique is used to solve the inhomogeneous problem for the full mesh. The inner iteration scheme for solving the inhomogeneous multidimensional difference equations is detailed. Numerical stability of the block inversion technique is established. Applications of the block inversion technique are illustrated for both a triangular and a hexagonal mesh. Convergence behavior is described. 11 references. (M.L.S.)

40433 (CONF-690401–, pp 234-46) REDUCTION OF MACHINE TIME IN DISCRETE ORDINATES CALCULATIONS. Sullivan, Robert E.; Yu, Dahsoong, Albers, Lynn K. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center).

Use of the two-dimensional Sn computer code for reactor kinetics calculations, TDSN, is discussed. Modifications to the angular and spatial quadratures to reduce required machine time are described. Input data requirements and sources are given. Convergence criteria, quadrature order, eigenvalues, and running times are tabulated. 10 references. (M.L.S.)

40434 (CONF-690401–, pp 247-55) TWO-DIMENSIONAL TRANSPORT THEORY PROGRAM IN A MODULAR SYSTEM ENVIRONMENT. Friedman, Jack P.; Crawford, Bruce W. (Knolls Atomic Power Lab., Schenectady, N. Y.).

Modular systems concepts are defined and described. Application of the modular system to solution of two-dimensional, multigroup, multiregion reactor physics equations—in the form of the program IT—is described. The equations solved by the IT program are given. Calculational procedures and program specifications are listed. (M.L.S.)

40435 (CONF-690401–, pp 297-303) CARONTE: THE EURATOM SYSTEM FOR AUTOMATIC CONTROL OF LINKED CALCULATIONS. Buccari, G.; Fattori, G.; Mongini-Tamagnini, C. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

The CARONTE modular system, which uses a flexible transfer data format, is discussed. The data sets, transfer program, test and input programs and control are described. The organization and applications of the system are discussed. (M.L.S.)

40436 (CONF-690401–, pp 304-12) THE CODNUC SYSTEM: A MODULAR SYSTEM OF SUBROUTINES FOR REACTOR CALCULATION. Bayard, Jean-Paul; Boudet, Roger (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

The CODNUC modular system for reactor calculations is described in some detail. The data sequence, auxiliary system, and standard subroutines used with the system are described. (M.L.S.)

40437 (CONF-690401–, pp 313-23) HITACHI NUCLEAR CODES CONTROL SYSTEM, NCCS. Watanabe, T.; Arai, K.; Noda, T.

The NCCS modular system for reactor calculations is discussed. The functioning and operation of the systems data manager, datapool, and subroutines are described. Flow charts for program execution and for the data manager are shown. Typical examples of input data and inter-module communications programs are given. (M.L.S.)

40438 (CONF-690401–, pp 324-36) JOSHUA: A REACTOR PHYSICS COMPUTATIONAL SYSTEM. Honeck, H. C.; Suich, J. E.; Jensen, J. C.; Bailey, C. E.; Stewart, J. W. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.).

A description is given of the orientation, organization, and operation of the JOSHUA computational modular system for third generation computers. Applications development for the JOSHUA system is outlined; facilities provided to the JOSHUA user are described. Interactions of named data, precompiler, and data management modules are summarized; terminal facilities are described. (M.L.S.)

40439 (CONF-690401–, pp 337-43) RECENT DEVELOPMENTS AND CAPABILITIES IN THE ARC SYSTEM. Just, L. C.; Walker, P.; Toppel, B. J. (Argonne National Lab., Ill.).

The definitions of the computational, directive, and system modules utilized in the ARC computational system are given. Subroutines and program modules are defined; program implementation and execution are described. Systems organization and libraries are outlined; object capabilities are discussed. (M.L.S.)

40440 (CONF-690401–, pp 391-414) THE USE OF HYBRID COMPUTERS IN THE ITALIAN CNEN NUCLEAR PROGRAMME. Mathis, A. (Comitato Nazionale per l'energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari).

Advantages and disadvantages in using either analog and digital computers for solution of dynamics problems for power reactors are discussed. Errors are analyzed as a function of error frequency for analog and digital integration. The uses of hybrid computers are discussed. The simulation of reactor cores and heat exchangers is described. 19 references. (M.L.S.)

40441 (CONF-690401–, pp 451-70) COMPUTER INDEPENDENCE OF LARGE REACTOR PHYSICS CODES WITH REFERENCE TO WELL BALANCED COMPUTER CONFIGURATIONS. Froehlich, Reimar (Gulf General Atomic, Inc., San Diego, Calif.).

The optimization of computer codes which utilize the multilevel storage systems for reactor physics calculations is discussed. The concept of a well balanced computer configuration is related to a specific computer code; the conventional methods used in obtaining a well balanced configuration are described. Efficient use of multilevel storage hierarchy is discussed. The ideas and equations for the coarse mesh rebalancing techniques are summarized. These coarse mesh techniques are illustrated by considering a TRIGA reactor and an HTGR power reactor; calculated data are presented graphically and in tabular form. 18 references. (M.L.S.)

40442 (CONF-690401–, pp 482-91) BURNUP SYSTEM CONTROL AND CALCULATION METHOD. Volk, E. R.; Gubkin, J. S.; Wehmeyer, D. B.; Yeh, C. S. (Atomic Power Development Associates, Inc., Detroit, Mich.).

A one- or two-dimensional burnup system for use with the multigroup diffusion code SCRAMBLE III is described. The burnup control criteria and burnup control methods are described. A flow chart for the combined burnup system—SCRAMBLE III code is shown. The calculational method used in the burnup system is described; the equations are given. (M.L.S.)

40443 (CONF-690401–, pp 659-75) EXPERIMENTAL MONTE CARLO PROGRAM FOR THREE DIMENSIONAL NUCLEAR SYSTEMS. Shapiro, Charles S. (IBM Scientific Center, Palo Alto, Calif.).

The feasibility of using the Monte Carlo technique for solving large three-dimensional reactor problems is evaluated. Methods for analysis and physical assumptions necessary for solution to

the neutron transport theory equations are outlined. The resultant program is described; a flow diagram is included. The types of problems that the program handles are described. Results of the application of the program to the calculation for the fission source distribution of a ZPR-3 fast reactor are given. (M.L.S.)

40444 (ORNL-TM-2500) XSDRN: A DISCRETE ORDINATES SPECTRAL AVERAGING CODE. Greene, N. M. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center); Craven, C. W. Jr. (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 134p. Dep. CFSTI.

XSDRN is a discrete ordinates spectral code for the generation of nuclear multigroup constants in the fast, resonance, and thermalization energy regions. A variable dimensioning technique is employed which optimizes the use of core storage. The code calculates an arbitrary number of flux moments for zero or one-dimensional systems. Several problem types are provided for, including fixed source, eigenvalue, and criticality search. Extensive cross section libraries are available which can be reduced, using calculated fine-group fluxes, to arbitrary broad-group structures. Provisions are available to produce library tapes for several codes, and modifications can be easily made to include other codes. Input/output formats and a program write-up are included. 19 references. (auth)

40445 (RT/FIMA-(69)1) NUMERICAL METHODS OF SEVERAL NUCLEAR DIFFUSION CODES AND OF REACTOR LIFE. Daneri, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1969. 43p. (In Italian). Dep.

The two-group neutron diffusion equations, delayed neutron equations, and precursor equations for description of reactor core neutronics are presented; eigenvalue solutions to these equations are given. Characteristics of the following diffusion codes are summarized: SQUID-1, SQUID-2π, SQUID-360, EREBUS, TRITON, and CoNDoR. Geometric representation, calculation of self-shielding factors and macroscopic cross sections and burnup, or depletion, calculations are discussed. The finite differences and iterative methods for solution of the diffusion problems are outlined. 23 references. (M.L.S.)

40446 (WAPD-TM-781) BE-21: A FEW-GROUP SLAB TRANSPORT PROGRAM IN FORTRAN-IV. Schmidt, E. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1969. Contract AT(11-1)-Gen-14. 20p. Dep. CFSTI.

BE21 is a program written in FORTRAN IV for the CDC 6600. The program solves the few-group, slab geometry transport equation in the discrete ordinates approximation. Either homogeneous or inhomogeneous problems are permitted. In the former case either fission or time constant eigenvalues are found for arbitrary spatial modes. An exact spatial differencing scheme is included reducing the overall error of approximation to that due to angular and energy differencing. The maximum number of ordinates is 60 which may be divided arbitrarily among the groups subject to the condition that the ordinates in each group be nonzero and symmetric. (auth)

40447 (WAPD-TM-877) JITER: A FORTRAN IV PROGRAM FOR THE COMPUTATION, FROM ONE-DIMENSIONAL MODAL KINETICS MODELS, OF STATISTICAL PARAMETERS MEASURED IN REACTOR FLUCTUATION EXPERIMENTS. Natelson, M.; Harris, D. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1969. Contract AT(11-1)-Gen-14. 30p. Dep. CFSTI.

JITER is a FORTRAN-IV program which computes statistical parameters measured in reactor fluctuation experiments. These are the dispersion parameter, the modified coefficient of correlation, the frequency dependent part of the power spectral density, and the cross power spectral density. The computation is done as an expansion in the decaying modes of one-dimensional, few-group kinetics models. (auth)

40448 (WANL-TME-1809) AN ASSEMBLY LANGUAGE VERSION OF GRIND FOR THE CDC 6600 COMPUTER. Collier, G.; Roth, R. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). June 18, 1968. Subcontract SNP-1. 90p. Dep. CFSTI.

An assembly language version of the GRIND subroutine has been written as an attempt to make the two-dimensional Discrete Ordinates Transport code (DOT) run faster. Comparisons are made with results obtained from FORTRAN and ASCENT programs using the same input data. A discussion is given on how to carry a subroutine argument list, with variable dimensions, through COMMON. Listings of the various FORTRAN and ASCENT programs are included. (auth)

40449 SOLUTIONS FOR QUASI-LINEAR STEADY STATE EQUATIONS FOR NEUTRON DIFFUSION IN PLANE LAYERS. Moskalev, O. B. Zh. Vychisl. Mat. I Mat. Fiz., 9: 724-9 (May-June 1969). (In Russian).

Previously, calculations of simple idealized problems revealed the existence of two steady-state neutron distributions in a reactor with equilibrium concentration of ^{135}Xe and a positive temperature coefficient. An attempt was made of finding the existence and possible number of positive solutions for such steady state equations. Two simple steady-state quasilinear equations of neutron diffusion in a plane of univalued nuclear reactor with an inverse relation between the neutron flux and multiplying properties of the media are given. (R.V.J.)

40450 STABILITY OF A REACTOR WITH A DISCRETE, STOCHASTIC, CONTROL SYSTEM. Ronzhin, O. B.; Sabaev, E. F. At. Energ. (USSR), 26: 377-8(Apr. 1969). (In Russian).

It is assumed that the regulating step is constant, that time processes are taken into account only in a servo loop according to the Xe poisoning, and that complete and instantaneous compensation of power deviations from the equilibrium value takes place at the end of each regulating step. The behavior of the system is studied with a random control step. The correction vector is a power function of time that is related to the system constant at discrete moments of time. The control step is a stationary random quantity with a given distribution of probability density. Transition is made from the vector correction equation to the corresponding system of difference, stochastic equations. The exponential stability on the average is investigated and ways of determining the critical time constant are presented. (TTT)

40451 MONTE CARLO PRINCIPLES AND NEUTRON TRANSPORT PROBLEMS. Spanier, Jerome; Gelbard, Ely M. Addison-Wesley Series in Computer Science and Information Processing. Reading, Mass., Addison-Wesley Publishing Company, 1969. 245p. $14.95. (TID-25125).

A book on Monte Carlo principles and neutron transport problems contains the following chapters: Fundamentals of Monte Carlo Methods; Discrete and Random Walk Processes; Standard Variance Reduction Techniques; Use of Superposition and Reciprocity in One-Energy Problems; Computation of Thermal Neutron Fluxes; and The Superposition Principle in Resonance Escape Computations. (M.L.S.)

40452 HIGHER ORDER PERTURBATION METHOD IN REACTOR CALCULATION. Saito, Reiko; Katsuragi, Satoru (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo), 6: 303-7(June 1969).

The higher order perturbation theory is applied to the one-dimensional multi-group diffusion equation. The method of calculating the eigenvalue, eigenfunction and adjoint function of the higher mode is established for a non-Hermetian matrix. The diffusion equation is solved by the higher order perturbation method, through the use of the eigenvalues, eigenfunctions and adjoint functions of the higher modes. The newly developed method is applied to the estimation of reactivity effect in a reactor. 5 references. (auth)

40453 TEMPERATURE DEPENDENCE OF PARAMETERS USED IN INTERMEDIATE TREATMENT OF RESONANCE ABSORPTION. Ishiguro, Yukio; Inoue, Shuji; Takano, Hideki (Japan Atomic Energy Reserach Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo), 6: 308-14(June 1969).

The temperature dependence of the intermediate parameters used in intermediate-resonance treatment has been investigated through an exact-numerical approach. In calculating the Doppler coefficient of the resonance integral with the interference between resonance and potential scattering taken into account, the temperature dependence of the parameter for the absorber becomes quite important, and neglect of the temperature dependence gives rise to serious errors in the Doppler coefficient of the resonance integral. In the case of the parameter for moderator scattering, however, hardly any temperature dependence is observed. A simplified method is proposed for taking account of the temperature dependence for the IR parameter in intermediate resonance approximation. This method is an interpolation approach based on the results obtained from the foregoing exact numerical calculation. The simplified method proposed gives good results for the Doppler coefficient of the resonance integral. 17 references. (auth)

Experimental Applications

40454 (BAW-3867-8) FAST BREEDER REACTOR STATIC PHYSICS METHODS DEVELOPMENT AND ANALYSIS PROJECT. Quarterly Technical Report, January-March 1969. Tilford,

J. M.; Livolsi, A. Z. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). June 1969. Contract AT(30-1)-3867. 29p. Dep. CFSTI.

The testing of versions of the MC² computer program is described. Running times for the various versions are compared. Progress in the development of design-oriented, one-dimensional criticality and depletion code FARED is presented. Corrections for the DAMMET and ETOE programs are included. (D.C.C.)

40455 (CONF-690401-, pp 650-8) USE OF THIRD GENERATION COMPUTERS IN MONTE CARLO CRITICALITY CALCULATIONS. Cross, N. F.; Crume, E. C. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center).

Use of third generation computers for application of Monte Carlo Methods to solution of criticality problems is discussed. The advantages of the large computers are related to the criticality calculations. Capabilities and execution of the KENO program are discussed; some of the search systems incorporated in KENO are described. 8 references. (M.L.S.)

40456 EFFECTS OF MULTIPLE CONTROL RODS. Oyama, Akira; An, Shigehiro; Tsai, Jensan (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo), 6: 315-21(June 1969).

A new method of calculating the effects of multiple control rods is presented. The reactor is divided into two parts—the uniform fuel region and the control rods. The sinks for both thermal and epithermal fluxes of the control rods are taken into account. This method overcomes such disadvantages of the conventional methods as limitations on the number, the properties, and on the locations of the inserted control rods, as well as the considerable calculating time required. The validity of the theory proposed was ascertained by comparisons with experiments in a natural U fueled, water moderated subcritical facility and with results obtained with the conventional method. 3 references. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 37910, 38023, 38026, 38040–38045, 38047–38055, 38057–38059, 38061, 38062, 38089, 38134–38136, 38144–38147, 38152, 38154, 38156, 38159–38161, 38166, 38240, 38247, 38338, 38358, 38378, 38381, 38917, 38918, 38924, 38925, 38928, 38929, 38939–38941, 38944, 38945, 39015, 39016, 39020, 39028, 39030–39032, 39034–39037, 39044, 39065, and 39526.

40457 (ORNL-tr-2131) CONTROL OF THE HOMOGENEITY OF COLAMINATED PLATES BY PHOTOMETRY. Destribats, Marie Therese; Pillet, Claude; Leblanc, Michel ([Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires]). Translated for Oak Ridge National Lab., Tenn., from report CEA-CONF-1079. 17p. Dep. CFSTI.

The apparatus for the automatic inspection of U distribution in laminated plates by photometry of the radiograph is described. The problem of opacity is overcome by radiographing either side of the fuel plate and the entire length with two standards corresponding to the minimum and maximum contents in terms of density. The opacity of each point on the radiograph is then compared with the opacity of the standards, at points located in the same transverse plane. Advantages of this method and its accuracy are described. (auth)

40458 TESTING FOR FUEL ELEMENT SHEATHING FAILURES IN NUCLEAR REACTORS. Jackson, George Oliver; Burton, Eric John; Evans, Paul Bernard Francis; Cartwright, David Kendall (to United Kingdom Atomic Energy Authority). British Patent 1,156,342. June 25, 1969. Filed Nov. 12, 1965.

Reference is made to methods and apparatus for testing for fuel sheathing failure in liquid metal cooled fast reactors by detection of delayed neutrons in a coolant sample. A neutron detector is provided outside the reactor containment vessel and adapted for detecting neutrons emitted from coolant at a location inside the vessel and adjacent to the detector. Various systems for sampling the coolant are described, including detection of neutrons at a heat exchanger outlet. (UK)

40459 THERMIONIC FUEL ELEMENT FOR NUCLEAR REACTOR. (to Siemens- Schuckertwerke Aktiengesellschaft). French Patent 1,495,461. Filed May 25, 1966.

A thermionic fuel element is described which consists of a porous mass of fissionable material disposed in a tubular container, a tubular emitter surrounding and contacting the container, a tubular collector surrounding and spaced from the emitter, and a device for removal of the gaseous fission products formed during operation. The porous mass of nuclear fuel is composed of cladded spherical particles having a diameter of 10 to 30 μ. Preferably the fuel particles consist of U and are cladded by a deposit of W formed by thermal decomposition of $W(CO)_6$. In order to improve the thermal and electric conductivity of the porous mass the fuel particles may be mixed with spherical particles consisting of a non-fissionable metal. (NPO)

40460 NUCLEAR FUEL CARTRIDGE. (to United Kingdom Atomic Energy Authority). French Patent 1,495,979. Filed Oct. 6, 1966.

A fuel cartridge is described comprising a cylindrical casing and a plurality of parallel longitudinal coolant channels surrounded by pellets of fritted nuclear fuel. The pellets are laterally spaced from each other so as to leave narrow longitudinal interstices between them. The pellets consist of a mass of fuel particles which fill the interstices and are compacted by vibration, preferably to a degree of 88% of the theoretical density. Preferably the casing and the coolant channels are formed from Zr and the fuel consists of uranium or plutonium oxide or a mixture thereof. (NPO)

40461 HIGH SPEED TEMPERATURE MONITOR. Goosey, M. H.; Dexter, A. H.; Wilson, J. N.; Leep, R. W.; Hodder, W. K.; Brady, E. R.; Page, L. C. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,459,925. Aug. 5, 1969.

A high speed temperature monitor has been provided which scans a large number of thermocouple inputs to provide essentially a continuous monitoring with a minimum of data channels. The monitor reads sequentially the output from as many as 2500 reactor thermocouples ten times each second. These readings are amplified and translated into machine language. These machine signals next enter a special purpose digital computer whose operation is carefully synchronized to the scanning rate so as to minimize memory requirements. Readouts are incorporated to permit surveillance of the temperature distribution in the reactor and control of the reactor. (AEC)

40462 NUCLEAR REACTOR FUEL PLATE CELL. (to Commissariat a l'Energie Atomique). French Patent 1,295,976. Filed May 2, 1961.

A nuclear reactor fuel plate cell is described comprising two spaced apertured cheeks for receiving fuel plates. A plurality of junction elements extend between the cheeks to locate the plates. A pressure device is adjacent one end of the cell to urge plates toward the other end of the cell. A tubular ferrule at the other end extends between the cheeks and presents a partly spherical external surface for reception by a complementary seat member in a support plate of the reactor. Preferably each junction element comprises two indented pieces in the form of combs fixed face-to-face on the cheeks so that fuel plates may be disposed in the indentations in the combs. A support junction element also has the form of a comb and is provided in the vicinity of the tubular ferrule. (NPO)

40463 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Ross, Wilfred Thomas; Venier, Dominic Ambrose (to General Electric Co.). British Patent 1,152,823. May 21, 1969. Priority date Oct. 19, 1965, United States.

REACTOR FUEL ELEMENTS—springs for zirconium alloy plugged tube type, description of chromium coated helical (D.C.C.)

40464 BURNABLE POISON RODS FOR A NUCLEAR REACTOR. (to Westinghouse Electric Corp). British Patent 1,152,305. May 14, 1969. Priority date June 23, 1967, United States.

BURNABLE POISONS—control elements of boron containing glass, description of zirconium alloy clad

REACTOR CONTROL ELEMENTS—description of zirconium alloy clad boron containing glass, burnable poison (D.C.C.)

40465 NUCLEAR REACTOR WITH THERMIONIC CONVERTER ARRAY. Bensussan, Andre Marc (to CSF–Compagnie Generale de Telegraphie). U. S. Patent 3,439,193. Apr. 15, 1969. Filed Jan. 5, 1965.

A thermionic converter providing a number of hollow anode elements and a number of cathode elements containing nuclear fuel and having electron emissive areas is described. The anode and cathode elements are arranged in columns and rows in a checkerboard arrangement with the columns being surrounded by dielectric material. All the elements in every row are electrically connected in series. (Offic. Gaz.)

40466 THERMIONIC FUEL ASSEMBLY. (to Siemens-Schuckertwerke Aktiengesellschaft). French Patent 1,464,826. Filed Nov. 24, 1965.

A fuel assembly is described which consists of a plurality of thermionic fuel elements connected in series and coaxially stacked to a column. The nuclear fuel is disposed inside the emitter electrodes. Each of the diodes has a tubular form, the collector surrounding the emitter leaving a gap between their adjacent surfaces which are conical. The elements are centered by means of cylindrical bodies, preferably consisting of a ceramic, which are stacked to a column inside the tube and are pressed against one another by means of a spring. In a modification the adjacent surfaces of the collector and the emitter are separated by a gap having a saw teeth-shaped longitudinal cross-section. The collector and the emitter of adjacent diodes are connected in series by means of laminated elastic members. (NPO)

40467 THERMIONIC NUCLEAR FUEL ELEMENT. (to Brown, Boveri and Cie). French Patent 1,437,187. Filed June 16, 1965.

A thermionic fuel element is described which consists of a diode and nuclear fuel disposed inside the emitter electrode. Data are given for the preferred proportion of the quantity of the fuel to the area of the emitter at different grades of enrichment of the fuel. The emitter is formed as a cylindrical body provided with longitudinal channels, transverse circular chambers or holes in which fuel bodies having the form of bars, disks or pellets are disposed in such a way as to provide space for accommodating the expansion of the fuel during operation. In a modification the emitter is a tubular body, the fuel being disposed as a cylindrical layer on the inner wall of the tube. Data are given for the preferred dimensions of the bars, the disks and the layer at different grades of enrichment of the fuel. In another modification the fuel and the material of the emitter are dispersed into one another, the material having the higher melting-point forming the matrix. (NPO)

40468 MODEL ANALYSIS AND THE DESIGN OF PRESTRESSED CONCRETE NUCLEAR REACTOR STRUCTURES. Godden, W. G. (Univ. of California, Berkeley). Nucl. Eng. Design, 9: 408-20(Apr. 1969).

The use of model analysis in design is discussed. Basic similitude requirements covering response to operational conditions, collapse, and thermal loading are presented together with some of the problems associated with scale effects in the structural system and in the properties of materials. 18 references. (auth)

40469 HEAT EXCHANGING MEDIUM FOR NUCLEAR REACTOR. (to Babcock and Wilcox Co.). French Patent 1,460,238. Filed Dec. 15, 1965.

A heat exchanging medium for a nuclear reactor is described which consists of a suspension of solid particles in water or water vapor. Preferably particles of graphite or synthetic mica are used. Having passed the reactor the suspension is fed into a separator, the water vapour being directed into a turbine and the particles being remixed with the water which leaves the turbine. The water preferably is vaporized before the mixing. (NPO)

40470 THERMIONIC FUEL ELEMENT. (to Compagnie Francaise Thomson-Houston). French Patent 1,423,443. Filed Feb. 3, 1965.

A thermionic fuel element is described which consists of a tubular emitter surrounded by a tubular collector and spaced therefrom by a cylindrical gap which contains Cs vapour. A cylindrical mass of nuclear fuel is disposed inside the emitter and provided with an axial channel accommodating the gaseous fission products formed during operation. The emitter is composed of an inner layer consisting of a non-reactive refractory metal which is in contact with the fuel, an intermediate layer consisting of a conducting material having a low neutron absorbing cross-section, and an outer layer consisting of a refractory metal. Preferably the inner and outer layers consist of W, Re, Mo or alloys thereof and the intermediate layer is composed of Nb or Mo. (NPO)

40471 THERMIONIC FUEL ELEMENT FOR NUCLEAR REACTOR. (to Siemens-Schuckertwerke Aktiengesellschaft). French Patent 1,473,456. Filed Mar. 11, 1966.

A fuel element is described which consists of thermionic diodes and a nuclear fuel preferably disposed inside the emitter electrodes. The fuel is composed of granules of a U-compound having internal cavities, absorbing the phenomena of expansion of the fuel and formation of gaseous fission products during operation. Preferably the fuel consists of spherical UO_2-particles, cladded with W, and embedded in a matrix consisting of an alloy, e.g., a Mg–Ti or a Mg–Ti–Zr alloy. (NPO)

40472 THERMIONIC NUCLEAR FUEL ASSEMBLY. (to Brown, Boveri and Cie). French Patent 1,404,837. Filed July 31, 1964.

A nuclear fuel assembly is described which consists of a plurality of cylindrical thermionic fuel elements connected in series and coaxially stacked to a column. The cylindrical emitter and collector electrodes of each element are separated by an annular gap containing Cs vapor. The collector electrodes of adjacent elements are isolated from one another by a cylinder consisting of a ceramic. Each collector is connected in a series with the emitter of an adjacent element by a conical member consisting of a carbide, a nitride or a boride of a refractory metal, or a mixture thereof. Preferably the member is cladded with a non-conducting material, resisting attack by cesium vapor, e.g., Al_2O_3. (NPO)

40473 CONTROL RODS FOR NUCLEAR REACTORS. Hellman, Erik (to Allmaenna Svenska Elektriska Aktiebolaget). U. S. Patent 3,448,008. June 3, 1969. Priority date Sept. 16, 1966, Sweden.

A control rod for nuclear reactors is described which comprises absorber plates with a plurality of hollow spaces containing neutron absorbing material. Each plate is built up of one of a small number of plate shaped pieces of material in which the hollow spaces are drilled. The spaces extend substantially perpendicular to the longitudinal direction of the rod and are in communication with each other through pressure equalizing channels. (Offic. Gaz.)

40474 NUCLEAR REACTOR WITH THERMIONIC CONVERTERS. Stahl, Kurt; Langpape, Reinhart; Rasor, Ned S. (to Brown, Boveri and Cie, A.G.). U. S. Patent 3,440,455. Apr. 22, 1969. Filed May 11, 1967.

A nuclear reactor with thermionic converters for direct conversion into electrical energy of heat produced by nuclear fusion is described. The novel thermionic converters are arranged within a reactor core perpendicularly to an imaginary plane passing through the center of the core and specularly arranged relative to each other, i.e., with surfaces facing toward one another, and sealed vacuum-tightly relative to each other. The thermionic converters are provided with outlet pipes for the fission gases, and coolers for the thermionic converters are provided, located at the front face of the reactor core. (Offic. Gaz.)

40475 IMPROVEMENTS IN OR RELATING TO CLOSURE DEVICES FOR PRESSURE VESSELS. Hilton, Raymond Kenneth (to United Kingdom Atomic Energy Authority). British Patent 1,154,215. June 4, 1969. Filed Aug. 3, 1966.

Reference is made to a method for sealing large diameter penetrations in pressure vessels by removable closure devices, and the disadvantages of presently used closures for this purpose are pointed out, especially in regard to maintaining the leak-tightness of gaskets. In the system described a closure plug and gasket are employed, the gasket being deformable to effect a seal in spite of small axial displacements of the closure on its seating. The closure plug is loosely inserted into the penetration so as to impart, by virtue of its weight, a sealing deformation to the gasket against the pressure vessel structure. A "keeper" is detachably connected to the pressure vessel wall so as to transmit to the wall thrust exerted on the closure plug by the pressurizing fluid in the vessel. The "keeper" may be a ring having a fast screw thread driven by gear teeth cut in the thread crests. The closure plug may have penetrations communicating with stand pipes which extend through the clearance in the center of an annular keeper, giving controlled access to the interior of the pressure vessel. (UK)

40476 COOLING OF NUCLEAR REACTORS. Stamford, Stanley; Terry, James Bernard; Gratton, Charles Peter; May, William Charles (to United Kingdom Atomic Energy Authority). U. S. Patent 3,441,477. Apr. 29, 1969. Filed Apr. 24, 1967.

Cooling, and particularly emergency cooling, of nuclear reactors in which the fuel is in the form of pin clusters is effected from a sparge pipe located centrally of each cluster supplied with coolant. The sparge pipe has a number of spaced outlets feeding plenum chambers formed axially along the clusters. The chambers communicate with channels between both the adjacent clusters of fuel rods. (Offic. Gaz.)

40477 TRANSVERSE BRACING GRIDS FOR CLUSTERS OF HEAT EXCHANGE ELEMENTS. Saunders, Alan Charles Anthony (to United Kingdom Atomic Energy Authority). British Patent 1,153,444. May 29, 1969. Filed Feb. 22, 1966.

Reference is made to transverse bracing grids for reactor fuel element clusters. Such grids are disposed between fuel element end supports and serve to brace the fuel elements against bowing. Various forms of grids have been proposed and used, disadvantages of which are enumerated. Disadvantages include the causing

of hot spots in the fuel elements by interruption of the coolant flow the setting up of "fretting," and susceptibility to damage during handling. In the system described the grid has a group or groups of cells, each cell for penetration by a single fuel element, and comprises two axially spaced annular members having resiliently flexible interconnecting limbs extending helically betweem them. The limbs are formed so as to provide protuberances extending radially inwardly of the cell so as to bear resiliently on the fuel element. The annular members of adjacent cells are peripherally contiguous. Several interconnecting limb arrangement variants are described. (UK)

40478 CONTROL ROD DRIVE SYSTEM. Fortescue, Peter; Ringsmuth, Richard J.; Schultz, George M. (to Gulf General Atomic Inc.). U. S. Patent 3,448,006. June 3, 1969. Filed June 7, 1967.

A control rod drive system for a nuclear reactor is described which utilizes a differential piston with a constant fluid pressure. The piston immediately drives the control rod into the core upon release of a latch in response to a scram signal. During normal control rod drive operation, the piston and control rod are coupled by the latch to a normal drive mechanism. An enlarged section or snubbing device on the piston rod cooperates with a tapered portion of the cylinder to brake the control rod at the end of its scram travel. (Offic. Gaz.)

40479 NUCLEAR FUEL ASSEMBLY. (to United Kingdom Atomic Energy Authority). French Patent 1,419,976. Filed Dec. 9, 1964.

A nuclear fuel assembly is described including a plurality of parallel elongate fuel elements. Spacing means are provided for spacing the elements transversely from one another intermediate their ends. The spacing means consist of resilient spacer members located between adjacent elements, and a support structure carrying the spacer members. The support is of skeletal form so as to cage the spacer members while allowing limited bodily movement of the members in the direction of the longitudinal axes of the fuel elements and preferably in directions transverse to the axes. An accompanying drawing shows a support structure comprising a series of sinuous strips joined together to form a grid assembly of cellular form, each cell being penetrated by a fuel element. The resilient spacer members have the form of spacer rings caged in apertures in the strips. They are located in a plane transverse to the longitudinal axes of the fuel elements. The dimensions of the apertures in the direction of the longitudinal axes of the elements are larger than the depth of the spacer rings so that the rings while being caged in the grid are movable relative to the grid in the longitudinal direction. A clearance is provided between the circumferential surface of the rings and the adjacent edges of the apertures in the strips so that the rings are also movable relative to the grid in the transverse directions. (NPO)

40480 NUCLEAR FUEL ASSEMBLY. (to Allmaenna Svenska Elektriska Aktiebolaget). French Patent 1,436,977. Filed June 2, 1965.

A fuel assembly is described which includes a plurality of parallel fuel rods and spacer means for determining the spacing apart of the rods. The spacer means consist of a rigid spacer body formed of tubular elements preferably of circular or quadrangular cross-section surrounding the fuel rods and spacer springs fastened to the tubular elements and arranged to bear against the fuel rods. Different forms of spacer springs and methods of fastening them to the tubular elements are shown in an accompanying drawing. (NPO)

40481 SPACING DEVICE FOR NUCLEAR FUEL ASSEMBLY. (to Siemens - Schuckertwerke Aktiengesellschaft). French Patent 1,497,083. Filed Oct. 20, 1966.

A spacing device for a fuel assembly is described which comprises a plurality of parallel hexagonal tubes the lateral faces of which are brazed together so as to form a unit having a honeycomb cross-section. Each tube surrounds an elongate fuel element of circular cross-section and is spaced by a plurality of projections extending from its inner wall. Preferably the projections are arranged in transversal planes, each plane comprising three projections displaced from each other at an angle of 120°. Two of the projections are rigid and the third is resilient. The unit is surrounded by a tubular casing, e.g., of graphite, having a cylindrical outer surface and an inner surface which is adapted for engagement with the lateral faces of the unit. (NPO)

40482 SPACING DEVICE FOR NUCLEAR FUEL ASSEMBLY. (to Licentia Patent-Verwaltungs- GmbH). French Patent 1,465,164. Filed Jan. 21, 1966.

A device is described for spacing apart a plurality of parallel nuclear fuel rods which are arranged so as to form a pattern of squares in the cross-section of the assembly. Each fuel rod is spaced apart from the adjacent rods by two sets of longitudinal inserts, which sets are laterally displaced from each other at an angle of 90°, each set comprising a rigid and a resilient insert disposed at opposite sides of the rods. Preferably the rigid inserts are elongate members provided with longitudinally spaced projections contacting the fuel bars, and the resilient inserts are curved double spring strips contacting the fuel bars with their mid-portions. In a modification only the casing of the assembly is provided with rigid projections, all the inserts being resilient. (NPO)

40483 GRID STRUCTURE FOR NUCLEAR FUEL ASSEMBLY. (to United Kingdom Atomic Energy Authority). French Patent 1,492,388. Filed Aug. 8, 1966.

A grid structure for a fuel assembly is described having a spacer plate with resilient inserts captive in apertures in the plate. The inserts are to locate fuel pins to be passed through the apertures with clearances between the pins and the boundary walls of the apertures allowing for flow of coolant over the pins. Preferably each resilient insert has at least three circumferentially equi-spaced lobes adapted to contact the fuel pins and at least three sets of circumferentially equi-spaced tabs between the lobes, each set having upper and lower tabs adapted to locate the insert with respect to the plate. The inserts may be held captive in annular recesses in the bounding walls of the apertures, the plate being of laminated form and the recesses being defined between shoulders on the laminations. (NPO)

40484 IMPROVEMENT IN NUCLEAR FUELS. (to United Kingdom Atomic Energy Authority). French Patent 1,407,387. Filed Aug. 18, 964.

The use of boron as a burnable poison suffers from the disadvantage that the production of gaseous He from the (n,α) reaction of B causes swelling of the fuel. This phenomenon is eliminated by using Hf instead of B, the products of neutron capture by Hf being mainly Ta with a small quantity of W and a negligible quantity of Re. In using Hf the fuel has to be enriched, preferably with ^{239}Pu, the Pu-content of the fuel not exceeding 5 at. % of the total nuclear material. Compounds of Hf may be used, e.g., HfC in carbide fuels and HfO_2 in oxide fuels, the ratio of fissile atoms to Hf atoms being in the range 1 : 5 to 1 : 10. (NPO)

40485 FUEL ASSEMBLY FOR A WATER-COOLED NUCLEAR REACTOR. (to Groupement Atomique Alsacienne Atlantique). French Patent 1,345,702. Filed Oct. 29, 1962.

A fuel assembly is described comprising an axial tube provided on its outside with at least two longitudinal radially extending fins which are provided on both sides with longitudinal grooves, and a plurality of arcuate fuel plates the longitudinal edges of which are slidably engaged in the grooves. The assembly is enclosed in a tubular casing provided at both ends with an elastic member which supports the fuel plates preventing vibration and accommodating thermal expansion of the plates. Water is circulated between the plates as well as through a central tube which is closed at both ends with a plug provided with a member which controls the coolant flow through the tube. Preferably the fuel plates consist of a U-Al-alloy cladded with Al. (NPO)

40486 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,426,494. Filed Feb. 23, 1965.

A fuel element is described wherein the fuel is encased in a sheath of stainless steel or is dispersed in a matrix of stainless steel. In a modification cermet pellets of oxide fuel are dispersed in a stainless steel matrix and sheathed in stainless steel. The stainless steel had the following composition in wt.%: Cr 16.5 to 17.5%, Ni 13.0 to 14.0%, Mo 2.0 to 2.75%, Mn 1.5 to 2.0%, C 0.06% max., Si 0.8% max., P 0.020% max., S 0.020% max., N 0.06% max., As 0.035% max., Sn 0.020% max., V 0.15% max., the remainder being Fe and unavoidable impurities. (NPO)

40487 METHOD FOR DIFFERENTIATING BETWEEN DIFFERENT TYPES OF FUEL ELEMENTS IN A NUCLEAR REACTOR. (to Brown Boveri/Krupp Reaktorbau GmbH). French Patent 1,477,988. Filed Apr. 28, 1966.

A method for differentiating between different types of fuel elements in a nuclear reactor, particularly between elements functioning as the normal fissionable material and elements present for test purposes, is described. The method consists of adding to the elements a substance which alters the neutron physical properties of the elements and then determining the resulting alteration of the properties. Preferably the test elements are provided with a substance which emits neutrons when exposed to γ-radiation, e.g., Be. In a modification a substance is added which partly absorbs neutrons, e.g., B. (NPO)

40488 METHOD OF COOLING A NUCLEAR REACTOR. (to Esso Research and Engineering Co.). French Patent 1,509,334. Filed Jan. 16, 1967.

A method is described for a nuclear reactor which comprises the use of a coolant consisting of a mixture of liquid hydrocarbons having a boiling point in the range 340 to 650°C. The mixture is prepared by thermal hydrodealkylation of a petroleum feed stock at a temperature in the range 540 to 815°C, a H_2 to liquid hydrocarbon ratio in the range 50 to 200 m^3 of H_2 per hl of hydrocarbon, and a pressure of 30 to 70 bars for a period of time from 20 to 120 seconds. (NPO)

40489 NUCLEAR FUEL ELEMENT ASSEMBLY. (to Combustion Engineering Inc.). British Patent 1,157,907. July 9, 1969. Priority date Dec. 2, 1965, United States.

REACTOR FUEL ELEMENTS—assemblies of parallel longitudinal, description of spaced polygonal (D.C.C.)

40490 NUCLEAR FUEL ELEMENT. (to Combustion Engineering, Inc.). British Patent 1,157,979. July 9, 1969. Priority date Dec. 2, 1965, United States.

REACTOR FUEL ELEMENTS—assemblies of parallel longitudinal, description of spring pin connected end supported (D.C.C.)

40491 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. (to Gulf General Atomic Inc.). British Patent 1,154,417. June 11, 1969. Priority date Apr. 14, 1967, United States.

REACTOR FUEL ELEMENTS—description of rod shaped vibration compacted carbon matrix (D.C.C.)

40492 DEVICE FOR SPACING NUCLEAR REACTOR FUEL ELEMENTS. Lass, James Lloyd; Venier, Dominic Ambrose (to General Electric Co.). British Patent 1,153,743. May 29, 1969. Priority date Aug. 26, 1965, United States.

REACTOR FUEL ELEMENTS—spacers for multiple parallel rod type, description of square lattice intersecting strip spring (D.C.C.)

40493 FUEL ASSEMBLY WITH SOLID END-FITTING. Gumuchian, Andre (to Commissariat a l'Energie Atomique). British Patent 1,155,350. June 18, 1969. Priority date June 6, 1967, France.

REACTOR FUEL ELEMENTS—assemblies of bundle arranged pin type, description of solid end supported internal coolant channeled (D.C.C.)

40494 A METHOD OF MEASURING THE NUCLEAR PHYSICAL BEHAVIOUR OF BODIES. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,151,724. May 14, 1969. Priority date June 10, 1965, Germany.

CRITICAL ASSEMBLIES—neutron flux variation in, fuel element physics measurements by

REACTOR FUEL ELEMENTS—physics measurements for, use of critical assembly environment for neutron flux variation (D.C.C.)

40495 THERMIONIC ENERGY CONVERTER AND NUCLEAR REACTOR CONTAINING SAME. Leffert, Charles B. (to General Motors Co.). U. S. Patent 3,455,781. July 15, 1969. Filed Apr. 20, 1967.

In a nuclear thermionic converter of the type which uses fission fragments to effect ionization of an interelectrode gas, a one fission fragment range thickness of fissile material is bonded to the collector electrode to provide a source of fission fragments. The emitter electrode is comprised of fissile material also and optionally may be clad with a coating impervious to fission fragments. (Offic. Gaz.)

40496 RESILIENT COLUMN. (to Societe Des Forges Et Ateliers Du Creusot). British Patent 1,154,763. June 11, 1969. Priority date Mar. 30, 1966, France.

A structure comprising a load bearing member supported on at least one resilient column is described. The column comprises a rolling element having coaxial part-cylindrical surfaces located between two resilient base units of triangular cross section. The base units contact adjacent bearing plates by way of the two edges parallel to the apex. A suggested application for the described bearing system is in a core support structure for a nuclear reactor. (H.D.R.)

40497 LEAK DETECTING AND LOCATING SYSTEM FOR NUCLEAR REACTOR CONTAINMENT VESSELS. Chave, Charles T. (to Stone and Webster Engineering Corp.). U. S. Patent 3,444,725. May 20, 1969. Filed Apr. 6, 1967.

A system for detecting and locating the area of leakage in nuclear reactor dual containment structures utilizes groups of conduits of varying lengths placed adjacent the inner surface of the outer containment shell and uniformly distributed over the entire area of the inner periphery of the shell. All of the conduits terminate at the apex of the containment structure so as to be accessible from outside the containment structure. The annular space between the containment shells is purged of air with an inert gas and the conduits are individually connected to a vacuum pump with the gas exhausted from each of the conduits passed through an oxygen analyzer. The detection of oxygen in any of the exhausted gas signals a leak in the outer containment shell and the conduit from which the oxygen is detected locates the area in which the leakage is occurring. (Offic. Gaz.)

40498 SHEATHS FOR NUCLEAR REACTOR FUEL ELEMENTS. Saunders, Alan Charles Anthony (to United Kingdom Atomic Energy Authority). British Patent 1,152,777. May 21, 1969. Filed May 26, 1967.

Reference is made to means of housing thermocouples in fuel element sheaths, so as to provide an accurate indication of temperature. The sheath has a local thickening of its wall so as to form an external protuberance aligned with its longitudinal axis, with a blind bore for housing a thermocouple hot junction. The protuberance is arranged in such a way as to cause very little disturbance to coolant flow and to the heat transfer pattern, and the temperature indicated by the thermocouple is substantially that of the unthickened part of the sheath. The sheath preferably has heat transfer roughening or fins which extend over the protuberance. (UK)

40499 THEORETICAL ANALYSIS OF FUEL ROD VIBRATION INDUCED BY PARALLEL COOLANT FLOW. Namatame, Ken. Nippon Genshiryoku Gakkaishi, 11: 398-405(1969). (In Japanese).

A theoretical analysis was made of fuel rod vibration in a nuclear reactor coolant channel with water flowing parallel to the rod axis. The analysis was based on the fact that the force inducing the fuel rod vibration is the pressure fluctuation of water flowing in the channel, and that this pressure fluctuation travels along the channel with a speed proportional to the mean water velocity. Using the result of the present analysis, a comparison was made with previous experimental results. It was found that the present analysis could very well explain the observed behavior of rod vibration, and that it could further serve in deducing other characteristics so far remaining unclarified. 17 references. (auth)

40500 NUCLEAR FUEL ASSEMBLY. Feutrel, Claude (to Commissariat a l'Energie Atomique). British Patent 1,156,440. June 25, 1969. Priority date July 5, 1967, France.

A fuel assembly is described which comprises elongated canned fuel pencils maintained in parallel along the nodes of a lattice by means of a support grid to which one end of each pencil is attached and by means of spacing braces. A series of rectilineal and parallel supporting beams are secured to the annular support grid with an elongated transverse cross section in the direction of coolant flow. Each beam is made of two strip components extending the full length of the beam which form a series of collars to retain the fuel pencil end-caps. (H.D.R.)

40501 A SYSTEM FOR INTERCONNECTING THE PRISMATIC BARS OF A MODERATOR STACK OF A NUCLEAR REACTOR. Boyer, Yves; Patarin, Louis; Vivien, Jean; Rouge, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,157,029. July 2, 1969. Priority date Feb. 9, 1966, France.

A moderator stack is described which comprises columns of blocks placed one upon another. The blocks are keyed to blocks in adjacent columns in such a manner that the columns can move vertically and transversely relative to one another and avoid strains from expansions and contractions. The keys make sliding engagement with the walls of keyways in the blocks and are formed by projections from the blocks or are separate elements. (H.D.R.)

40502 INFLUENCE OF SPEED OF COMBUSTION ON THE STABILITY OF THE NUCLEAR FUEL TOWARD SWELLING. Lazarevic, Dj. (Boris Kidric Inst. of Nuclear Science, Belgrade). Ind. Chim. Belge, 32: Special No., (Vol. 2), 41-4(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.2).

Published results show a favorable influence is exercised concurrently by the burnup rate and the precipitates of the second phase on the stability of the fuel toward swelling. A dynamic equilibrium model is proposed for the condition of the precipitates as a function of the specific power and of the temperature of the fuel in the reactor. It is estimated that in heavy water power reactors the metallic fuel can attain a very high burnup ratio. (tr-auth)

40503 CAPSULE FOR IRRADIATION TESTS. Hiratsuka, Yasumasa (to Hitachi Ltd.). Japanese Patent 1969-6798, Mar. 12, 1969. Filed June 18, 1963.

The proposed capsule is for test specimens to be placed near the reactor core for such tests as radiation damage, corrosion, tensile and impact strenths; all the specimens are placed in one capsule. The advantages of the method are high uniformity in the flow of coolant through the capsule, and firm fastening of the test specimens within the capsule. Small holes are cut through the walls of the capsule and grooves are also cut on the inside surface of the opposed two walls for the coolant to flow through the capsule, cooling uniformly the test specimens. Test specimens are fixed within the capsule by grooves opposed to each other. (NSA of Japan)

GENERAL

40504 (AEC-tr-6931/2) NUKLEONIKA. Translation of Nukleonika, 13: 131-250(1968). 112p. (TT-68-50011/2). CFSTI.

40505 (AEC-tr-6931/3) NUKLEONIKA. Translation of Nukleonika, 13: 251-360(1968). 104p. (TT-68-50011/3). CFSTI.

40506 (AEEW-R-543) ZIP MK 2: A FORTRAN CODE FOR CALCULATING THE EIGENVALUES (POLES AND ZEROS) AND FREQUENCY RESPONSES OF LARGE SETS OF LINEAR EQUATIONS REPRESENTING COMPLEX DYNAMIC SYSTEMS. Sumner, Helen M. (Atomic Energy Establishment, Winfrith (England)). Mar. 1969. 59p. Dep. CFSTI. UK 8s. 6d.

The KDF9/EGDON program ZIP MK 2 is the third of a series of programs for off-line digital computer analysis of dynamic systems; it was designed specifically to cater for the needs of the design or control engineer in having an input scheme which is minimally computer-oriented. It uses numerical algorithms which are as near fool-proof as the author could discover or devise, and has comprehensive diagnostic sections to help the user in the event of faulty data or machine execution. ZIP MK 2 accepts mathematical models comprising first order linear differential and linear algebraic equations, and from these computes and factorizes the transfer functions between specified pairs of output and input variables; if desired, the frequency response may be computed from the computed transfer function. The model input scheme is fully compatible with the frequency response programs FRP MK 1 and MK 2, except that, for ZIP MK 2, transport or time-delays must be converted by the user to Padé or Bode approximations prior to input. ZIP provides the pole-zero plot (or complex plane analysis), while FRP provides the frequency response and FIFI the time domain analyses. The pole-zero method of analysis has been little used in the past for complex models, especially where transport delays occur, and one of its primary purposes is as a research tool to investigate the usefulness of this method for process plant, whether nuclear, chemical or other continuous operation. (auth) (UK)

40507 (AEEW-R-639) NEWLIN: A DIGITAL COMPUTER PROGRAM FOR THE LINEARISATION OF SETS OF ALGEBRAIC AND FIRST ORDER DIFFERENTIAL EQUATIONS. Hopkinson, A. (Atomic Energy Establishment, Winfrith (England)). May 1969. 32p. Dep. CFSTI. UK 4s. 6d.

The techniques normally used for linearization of equations are not amenable to general treatment by digital computation. A computer program is described for linearizing sets of equations by numerical evaluations of partial derivatives. The program is written so that the specification of the non-linear equations is the same as for the digital plant dynamics simulation program, FIFI, and the linearized equations can be punched out in form suitable for input to the frequency response program FRP2 and the poles and zeros program ZIP. Full instructions for the use of the program are given and a sample problem input and output are shown. (auth) (UK)

40508 (AERE-M-2145) 7000 SERIES CAMAC CONTROLLERS. Richards, J. M. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1969. 22p. Dep. CFSTI. UK 3s. 6d.

CAMAC is a convenient system for the design of digital instruments, which has been specified by the International ESONE Committee. The 7000 Series of plug-in units is being developed to the CAMAC Specification, by AERE and industry in collaboration. While the operation of the digital units in the 7000 Series has largely been settled by the CAMAC Specification, the method of control and read-out of these modules by computers or other digital hardware has not been closely specified. A description is given of how the control of CAMAC — compatible modules is organized in the 7000 Series. (auth) (UK)

40509 (BNWL-1124) COMPUTER PROGRAMS FOR HARMONIC ANALYSIS AND SYNTHESIS OF TABULAR DATA. Oster, C. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 68p. Dep. CFSTI.

Three algorithms for the harmonic analysis and synthesis of tabular data are described. A brief discussion of the underlying theory of Fourier series approximation, the Fourier transform of such a series, and a method of inverting such a transform is included. These procedures have been coded as subprograms in FORTRAN V. A program using these subprograms is described. Also, listings of all routines under discussion as well as sample input and the resulting output are presented. (auth)

40510 (IN-1305) BIBLIOGRAPHY OF LASER PUBLICATIONS OF INTEREST TO EMISSION SPECTROSCOPISTS. III. Baldwin, Jon M. (ed.) (Idaho Nuclear Corp., Idaho Falls). July 1969. Contract AT(10-1)-1230. 12p. Dep. CFSTI.

Ninety-nine references continue the literature coverage of the previous reports, IN-1219 and IN-1262, to June 1, 1969. (M.C.G.)

40511 (MLM-1648) HYDRIDIC NATURE OF RARE EARTH PREPARATIONS WITH REDUCING PROPERTIES. Silver, G. L.; Seabaugh, P. W.; Smith, W. H.; Eckstein, R. R. (Mound Lab., Miamisburg, Ohio). Aug. 8, 1969. Contract AT(33-1)-Gen-53. 13p. Dep. CFSTI.

The precipitates that result from the dissolution of praseodymium in acetic acid and gadolinium in mucochloric acid contain hydridic hydrogen, as shown by the large fraction of HD in the gas released when the precipitates are decomposed with deuterium chloride. X-ray powder diffraction patterns of the compounds suggest they have the fluorite structure. The infrared spectra of the compounds are not amenable to easy interpretation. (auth)

40512 (NP-17718) ANNUAL REPORT, 1967. (Kernforschungsanlage, Juelich (West Germany)). [1967]. 229p. (In German). Dep.

The general development of the Juelich Nuclear Research Installation is outlined. The areas of publicity, management council, financing, organization, patent application, and safety supervision are covered. Research programs of the various member institutes in the fields of radiobiology, microbiology, zoology, botany, medicine, physical chemistry, radiochemistry, radiation chemistry, high energy physics, accelerator development, nuclear physics, solid state and superconductivity, direct energy conversion, plasma physics, reactor fuel and breeder elements, reactor theory, engineering and development, and electrical engineering are briefly summarized. The environmental monitoring, personnel monitoring, and operational monitoring of the Radiation Protection Section are also summarized. The publications and internal reports are listed. (J.S.R.)

40513 (NP-17921) ANNUAL REPORT, YEAR ENDED DECEMBER 31, 1968. (Australian Inst. of Nuclear Science and Engineering, Lucas Heights). 43p. Dep.

The activities of the Australian Institute of Nuclear Science and Engineering during the year ended 31st December 1968 are summarized. The Institute is an independent organization established to assist nuclear research and training in Australia and to make available to Australian Universities nuclear reactors and other facilities at the Australian Atomic Energy Commission's Research Establishment at Lucas Heights. Activities include conferences on nuclear physics and radiation chemistry, neutron diffraction studies, research and training grants, fellowships and studentships. A list of A.I.N.S.E. sponsored university research projects is attached. (UK)

40514 (NP-17963) PROGRESS REPORT NO. 10 [ON NUCLEAR STUDIES], JULY–DECEMBER 1967. (Institute of Nuclear Sciences, Lower Hutt (New Zealand)). 55p. (INS-259; AEC-308). Dep.

Research includes projects in nuclear physics, radiation research, isotope geochemistry—stable isotopes, radioactive dating and radioactive fallout, isotope applications, and instrumentation. (W.H.K.)

40515 (NYO-3399-195) EXPANSION OF FUNCTIONS IN BINOMIAL POLYNOMIALS. Gardiner, C. W. (Syracuse Univ., N. Y. Dept. of Physics). May 1969. 10p. (SU-1206-195). Dep. CFSTI.

We prove the following expansion and inversion theorem. Define polynomials

$$\rho_n(x) = \frac{(n-x)}{n!\,\Gamma(-x)}$$

and let F(y) have the properties

F(y) is analytic for $\mathrm{Re}\,y > \mu$ (i)

For all $\epsilon > 0$ $\lim_{y\to\infty} F(y)/y^{\lambda+\epsilon} = 0$ (ii)

let

$$f(x) = \sum_{n=0}^{\infty} \rho_n(x)\ F(n)$$

then

$f(x)$ is analytic for $Re\ x > \lambda$, (iii)

For all $\epsilon > 0$ $\lim_{x\to\infty} f(x)/x^{\mu+\epsilon} = 0$ (iv)

and

$$F(y) = \sum_{n=0}^{\infty} \rho_n(y)\ f(n). \quad \text{(v)}$$

(auth)

40516 (RFP-1290) LOW RANGE MOIST-AIR GENERATOR. McGuire, Daniel J. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). June 10, 1969. Contract AT(29-1)-1106. 7p. Dep. CFSTI.

A relatively inexpensive, manually operated, moist-air generator is described. The generator provides moisture levels from 5 ppM by volume to 50-percent relative humidity. It serves as a stable source of moist air for environmental comparison and calibration of humidity measuring equipment. Construction details of the moist-air generator are given. (auth)

40517 (RISO-M-914) DIGITAL POTENTIOMETER WITH FIELD-EFFECT TRANSISTOR SWITCHES. Hoejberg, K. Soee (Danish Atomic Energy Commission, Risoe. Research Establishment). June 1969. 12p. Dep.

A solid-state digital potentiometer (multiplying D/A converter) for a hybrid computer is described. The temperature drift due to the F.E.T. switches is discussed. (auth) (Denmark)

40518 (SCL-DR-69-73) A TECHNIQUE FOR COMPUTING THE DISCRETE FOURIER TRANSFORM OF LONG TIME SERIES. Humphrey, R. E. (Sandia Labs., Livermore, Calif.). July 1969. Contract AT(29-1)-789. 32p. Dep. CFSTI.

This report describes a technique that can be used to compute the discrete Fourier transform of a very long time series. Time domain decimation of the data is used to obtain sub-series which are of sufficiently short length that their discrete Fourier transforms can be computed using a so-called fast Fourier transform subroutine. The transformed series are then decimated to place the sequence of values in a convenient order for recombination. After recombination, decimation is used once again to reorder the data. A digital computer program that utilizes this technique has been written in FORTRAN language for the CDC 3600 computer and is included in the Appendix. (auth)

40519 (SLAC-104) BI-DIRECTIONAL AND HEURISTIC SEARCH IN PATH PROBLEMS. Pohl, Ira (Stanford Linear Accelerator Center, Calif.). May 1969. Contract AT(04-3)-515. 157p. Dep. CFSTI.

The shortest path problem is defined. Developments of algorithms for handling this type of problem are discussed; types of bi-directional methods, using a cardinality comparison strategy, and stopping conditions are considered. A description of the very general algorithm (VGA) is formulated; correctness proofs are given. A probabilistic analysis of the optimality of the cardinality comparison is detailed. Results of a computer program for VGA, written in ALGOL, are given; data are tabulated. A formal model for a heuristic search is developed; a heuristic path algorithm is constructed. Uni-directional and bi-directional heuristic search problems and theories are discussed; error effects and correctness are analysed. The ALGOL writeup for the VGA is presented; results of different search strategies in VGA are compared. The ALGOL program for the heuristic VGA solution to the fifteen puzzles is included. 63 references. (M.L.S.)

40520 (TID-3752) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Issued or in Progress During the Period March-April 1969. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 9p. Dep. CFSTI.

40521 (TP-372) RANK ONE METHODS FOR UNCONSTRAINED OPTIMIZATION. Powell, M. J. D. (Atomic Energy Research Establishment, Harwell (England)). June 1969. 28p. Dep. CFSTI. UK.

Many methods for unconstrained optimization depend on an estimate of the second derivative matrix of the objective function. The rank one methods obtain an estimate from first derivatives, in an economic and elegant way, that does not require any searches along lines in the space of the variables of the objective function. A new rank one algorithm is defined. (auth)

40522 (UCLA-10-P-14-78) INSTRUMENTING COMPUTER SYSTEMS AND THEIR PROGRAMS. Bussell, Bertram (California Univ., Los Angeles. Dept. of Computer Science). [1968]. Contract AT(11-1)-Gen-10. 12p. (CONF-690904-1). Dep. CFSTI.

From Pan-American Congress of Mechanical, Electrical, and Applied Engineering, San Juan, Puerto Rico.

A research program in computer instrumentation and measurement is described. This program has been developed with an eye toward minimizing artifact in the measuring process. The research is carried on in several phases. In the earliest phase, measurements are made on an object computer with instrumentation programs written in the object computer. These measurements yield instruction mix statistics of all, or any portion, of an object program at the machine language level. Timing measurements of portions of the object program can also be made by calling for appropriate instrumentation packages. The object program can be written at a compiler language level. The second phase reduces artifact by attaching external hardware to the object computer. This equipment acts as an observer of specially generated information signals from within the source program, or from electronic signals generated by sections of the object computer being observed. Data of this type are collected and analyzed in a second machine called the instrumentation computer. (auth)

40523 (UCRL-18726) METASTABLE IONS IN THE MASS SPECTRA OF N_2, NO, N_2O, AND NO_2. Newton, Amos S.; Sciamanna, A. F. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1969. Contract W-7405-eng-48. 3p. (CONF-690523-2). Dep. CFSTI.

From 17th Annual Conference on Mass Spectrometry and Allied Topics, Dallas, Tex.

Using a CEC Model 21-103B mass spectrometer modified to increase the pumping speed in the analyzer tube, to increase the sensitivity of the dc amplifier, and to accurately measure potentials applied to the metastable suppressor, metastable ions were observed in the mass spectra of N_2 and NO. In N_2O and NO_2, metastable dissociation of N_2^+ and NO^+ were also observed. (auth)

40524 (UCRL-18818) CARBON REPLICA PREPARATION FOR ELECTRON MICROSCOPY. Giba, Walter T.; Muller, Rolf H. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1969. Contract W-7405-eng-48. 15p. Dep. CFSTI.

Detailed procedures are given for the preparation of two-step carbon replica of metal surfaces for examination by transmission electron microscopy. The technique employs a plastic replicating film and is particularly suited for metal surfaces resulting from electrochemical dissolution. (auth)

40525 (UCRL-19230) INEXPENSIVE MAGNETIC TAPE FOR SMALL COMPUTER USE. Lechaczynski, M. A.; Robinson, L. B. (California Univ., Berkeley. Lawrence Radiation Lab.). June 1969. Contract W-7405-eng-48. 33p. Dep. CFSTI.

An inexpensive magnetic tape system for a small computer (SCC 650, 4K, 12 bit), using a DECTAPE transport TU55. This system will also be connected to a larger computer (SCC 660 16K, 24 bit). (auth)

40526 (UCRL-50645) STANDARD TEST FOR DETONATION PRESSURE MEASUREMENT. Cast, John C.; Hornig, Howard C.; Kury, John W. (California Univ., Livermore. Lawrence Radiation Lab.). June 12, 1969. 13p. Dep. CFSTI.

A standard test for measuring the detonation pressure of an explosive is described. Measured pressures are given for the following four explosives: TNT, 190 kbar; Comp B-3, 300 kbar; LX-04-1, 350 kbar; and PBX-9404, 375 kbar. (auth)

40527 (UCRL-71796) AN ITERATIVE, TIME DOMAIN METHOD OF SYSTEM RESPONSE CORRECTION. Ekstrom, Michael P. (California Univ., Livermore. Lawrence Radiation Lab.). June 23, 1969. 10p. (CONF-690806-2). CFSTI.

From Western Electronic Show and Convention, San Francisco, Calif.

A method is described for "optimum" correction of the convolutional distortion associated with linear physical systems. In contrast to previous techniques of system compensation, the scheme presented is formulated entirely in the time domain. The correction is based on minimizing a time domain error criterion subject to physical realizability constraints. The compensator network realization is determined by an iterative, time domain synthesis procedure. The problem solution is suitable for numerical calculation, examples of which are presented. (auth)

40528 ENERGY. Balke, S. Ind. Chim. Belge, 32: Special No., (Vol. 1), 29-41(1967). (In French).

From 36th International Congress on Industrial Chemistry, Brussels. See CONF-660905-(Vol.1).

The development of nuclear fission as a source of energy is discussed with respect to economics and technology. (D.H.M.)

40529 NUCLEAR INSTALLATION ACT, 1969. Elizabeth II, Ch. 18. London, Her Majesty's Stationery Office, 1969. 2p. 6d.

Act to make certain amendments in the Nuclear Installations Act, 1965 to bring the latter into conformity with international agreements. The amendments include restriction of liability for certain damage, adjustment of amounts available for meeting certain claims and for compensation, and extension of compensation in certain cases. (UK)

40530 AGREEMENT BETWEEN THE GOVERNMENT OF THE UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND AND THE GOVERNMENT OF THE REPUBLIC OF CHILE FOR CO-OPERATION IN THE PEACEFUL USES OF ATOMIC ENERGY. (With Exchange of Notes). Santiago, Nov. 1968. Atomic Energy, Chile No. 2 (1969). Cmnd. 4008. London, Her Majesty's Stationery Office, 1969. 10p. 1s. 9d.

40531 EXCHANGE OF NOTES BETWEEN THE GOVERNMENT OF THE UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND AND THE GOVERNMENT OF THE KINGDOM OF GREECE REGARDING SAFEGUARDS APPLICABLE TO AN ATOMIC FACILITY ON TRANSFER TO GREECE BY THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY. Athens, April 1968. Treaty Series No. 66 (1969). (Greece). Cmnd. 4042. London, Her Majesty's Stationery Office, 1969. 4p. 9d.